RUBBER RESEARCH INSTITUTE OF SRI LANKA ANNUAL REIVEW 1986

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THE RUBBER RESEARCH INSTITUTE OF SRI LANKA

1986 Annual Review

THE RUBBER RESEARCH INSTITUTE OF SRI LANKA

ANNUAL REVIEW 1986

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RUBBER RESEARCH INSTITUTE OF SRI LANKA

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(As at 31 December 1986)

Ex-Officio Members

The Director of Agriculture — Dr S. D. I. E. Gunawardena

Representative of the Treasury — Mrs M. N. Mendis

The Rubber Controller — Mr T. P. G. N. Leelaratne

The Director, Rubber Research Institute of Sri Lanka (upto 30 April) — Dr O. S. Peries. BAgrSc. (Melb.) PhD) (Bristol), MIBiol (*Vice Chairman*)

The Acting Director from 1 May — Mr S. W. Karunaratne BSc. (Cey.), MSc (Aston), ARIC, ANCRT, FPRI, FIC

Nominated Members

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Members nominated by the Low-Country Products Association of Ceylon

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Mr P. Eardley Perera

Secretary, Planters' Association of Ceylon

Mr C. S. Illangakoon

Small-holders' Representative — Mr L. R. Cooray

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Mr Rajah Salgado
Mr G. P. W. Silva
Mr Eardley Hermon
Mr L. R. Dahanayake (*Estate Superintendent, Dartonfield Group*)
Mr B. S. Ratnayake (*Secretary*)

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Mr R. Madene
Mr A. B. Weerasekera
Mr D. H. Giragama
Mr P. Eardley Perera
Mr V. A. de Silva
Mr Stanley de Silva
Mr D. L. Fernando
Mr M. M. A. Naina Marikkar
Mr Sepala Illangakoon
Mr S. S. R. Rodrigo
Mr J. Weragama
Mr K. M. G. M. Hapugoda
Mr N. G. D. Abeysinghe
Mr L. R. Dahanayake
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Mr B. S. Ratnayake (*Secretary*)

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Mr S. W. Karunaratne (*Acting Director*)
Mrs M. N. Mendis
Mr T. P. G. N. Leelaratne
Mr P. Eardley Perera
Dr C. S. Weeraratne
Mr B. S. Ratnayake (*Secretary*)

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Mr P. Eardley Perera (*Chairman*)
Mr S. W. Karunaratne (*Acting Director*)
Mr T. H. Wijesena
Mr M. C. Samarasekera
Mr R. W. Gunaratne
Mr B. S. Ratnayake (*Secretary*)

Secretary to the Board

Mr B. S. Ratnayake

Lawyers

M/s. F. J. and G. de Saram
Attorney-at-Law
P. O. Box 212.
Colombo.

M/s. De Silva and Gurusinghe
Attorney-at-Law.
157, Mihindu Mawatha,
Colombo.

Mr Manilal Fernando
Attorney-at-Law,
14, De Silva Road,
Kalutatra.

Auditors

Messrs H. T. Peiris and Co.,
Chartered Accountants,
P. O. Box 499,
Colombo 6.

Bankers

Bank of Ceylon,
York Street, Colombo 1.
Bank of Ceylon, Matugama.
Bank of Ceylon, Agalawatta.

Registered Office, Laboratories

Dartonfield, Agalawatta.

Colombo Office and Laboratories Consist of :

Rubber Research Board Office and
Advisory Services Department
Rubber Chemistry Department and
Specification Laboratory,
Telawala Road, Ratmalana,
Mt. Lavinia.

Tele: 715851
715752
713351

THE RUBBER RESEARCH INSTITUTE OF SRI LANKA

STAFF

((As at 31 December 1986)

Chairman	—	H. G. R. de Mel, F.C.I.P.
Director (*upto* 30 *April*)	—	O. S. Peries, BAgrSc. (Melb.), PhD (Bristol) M.I.Biol.
Acting Director (*from* 31 *May to* 31 *Dec.* 1986)	—	S. W. Karunaratne, BSc. (Cey.), Msc (Aston) ARIC, ANCRT, FPRI, FIC.
Deputy Director (Research)	—	** A. de S. Liyanage, BAgrSc (Cey.), PhD (Lond.)
Secretary to the Chairman	—	Mrs L. J. C. Perera.
Clerk/Typist	—	Miss S. N. Munasinghe.

RESEARCH DEPARTMENTS

Plant Science

Head of Department	—	Mrs A. C. I. Samaranayake, BSc (Cey.), PhD (Lond.)
Assistant Botanists	—	R. C. W. M. R. A. Nugawela, BSc (Cey.), MSc (Lond.) Miss G. P. W. P. Pushpika, BSc (Cey.) Miss M. S. Ranasinghe, BSc (Cey.)
Research Assistant (*Intercropping*)	—	V. H. L. Rodrigo, BAgrSc (Cey.)
Experimental Officers	—	L. S. S. Pathiratne, M.I.Biol., M.Phil. (Cey.) R. B. Gunaratne

Technical Officers	—	Miss C. W. Ranasinghe, BA (Cey.) Mrs G. A. Wijesekera Miss A. R. Kusum L. S. Kariyawasam K. A. G. B. Amaratunge R. P. Karunasena U. S. Weerakoon S. L. G. Ranjith R. S. Wijesundera
Experimental Assistants	—	S. Wilbert U. K. D. Lewis
Clerk/Typist	—	Miss. H. D. D. E. Jayasekera

Genetics & Plant Breeding

Head of Department	—	N. E. M. Jayasekera, BAgrSc (Cey.), PhD (Birm.)
Assistant Geneticists & Plant Breeders	—	* Mrs S. C. Dharamaratne, BSc (Cey.) D. P. S. T. G. Attanayake, BAgrSc (Cey.)
Experimental Officer	—	K. B. A. Karunasekera
Senior Experimental Assistant	—	B. M. S. G. Peiries
Senior Technical Officer	—	K. W. Rupatunga
Technical Officers	—	R. A. S. K. Ranatunga I. D. M. J. Sarath Kumara
Experimental Assistant	—	A. K. M. S. Senaratne

Plant Pathology

Head of Department	—	** A. de S. Liyanage, BAgrSc (Cey.), PhD (Lond.)
Assistant Plant Pathologists	—	* C. K. Jayasinghe, BSc (Cey.), MSc (Cey.) * Mrs N. I. S. Liyanage, BAgrSc (Cey.) MSc (Cey.) A. H. R. Jayaratne, BSc (Cey.), MSc (Cey.)

Senior Technical Officers	—	L. W. Amaratunga E. B. Fernando * W. .A. D. D. S. Wettasinghe
Technical Officers	—	*** Mrs P. C. Wrettasinghe S. S. Warnapura E. A. T. Senadeera
Clerk/Typist	—	Mrs W. S. P. Amarasekera

Soils & Plant Nutrition

Head of Department	—	N. Yogaratnam, BAgrSc (Alhabad), PhD (Lond.)
Agricultural Chemist	—	M. K. S. A. Samaraweera, BSc (Cey.), MSc (Bristol), PhD (Bristol)
Assistant Soils Chemists	—	* Mrs M. L. A. Samarappuli, BAgrSc (Cey.), D. M. A. P. Dissanayake, BAgrSc (Cey.)
Experimental Officers	—	W. C. Dayaratne A. M. A. Perera F. P. W. Silva H. D. S. P. Perera, BSc (Cey.)
Senior Technical Officer	—	J. G. de Mel
Technical Officers	—	Miss S. D. C. K. Maheepala Mrs M. K. Mahanama Miss P. A. L. Jayaweera Miss P. R. Munasinghe S. N. Silva P. Karunadasa A. H. U. Mitrasena A. N. Yakandawala B. A. Nandalal
Experimental Assistant	—	K. A. J. Wijenayake
Specification Assistant (Special Grade)	—	T. M. Ahamadeen
English Stenographer	—	Miss K. A. D. L. Rupasinghe

Rubber Chemistry, Biochemistry Polymer Chemistry, Specifications and Analysis, Rubber Technology & Development, Raw Rubber Development and Electronic Repair Unit

Head of Department	—	S. W. Karunaratne, BSc (Cey.), MSc (Aston), ARIC, ANCRT, FPRI, FIC
Head of Biochemistry Section	—	P. A. J. Yapa, BSc (Cey.), PhD (Lond.)
Head of Polymer Chemistry Section	—	A. Coomarasamy, BSc (Cey.), PhD (Aston)
Head of Rubber Technology & Development Section	—	W. S. E. Fernando, BSc (Cey.), MSc (Aston), PhD (Aston)
Head of Specifications and Analysis Section	—	** L. M. K. Tillekeratne, BSc (Cey.), MSc (Aston), PhD (Aston)
Head of Raw Rubber Development Section	—	M. C. S. Perera, BSc (Cey.), MSc (Cey.), PhD (Aust. Nat. Univ.)
Rubber Chemist	—	Mrs K. G. K. de Silva, BSc (Cey.), MSc (Cey.), PhD (Aston)
Assistant Rubber Chemists	—	* Miss N. M. V. Kalyani, BSc (Cey.) * M. D. R. J. Gunatilleke, BSc (Cey.), MSc (Aston) * E. D. I. H. Perera, BSc (Cey.) * W. M. G. Seneviratne, BSc (Cey.) * Miss S. A. P. P. Sirimanne, BSc (Cey.)
Research Assistant	—	L. B. K. Silva, BSc (Cey.), LPRI
Assistant Rubber Chemist/ Specifications Officer	—	P. A. D. T. Vimalasiri, BSc (Cey.), PhD (Univ. New South Wales)
Assistant Biochemist	—	Mrs S. I. Wickremasihnghe, BSc (Cey.)
Experimental Officers	—	H. K. Chandralal, BSc (Cey.) P. P. Jayasinghe, LPRI A. S. Dekumpitiya I. H. S. L. Weerasinghe W. W. D. Y. Jayasinghe, BSc (Cey.) D. D. Medagama

Senior Technical Officers	—	Z. E. Irugalbandara
Technical Officers	—	Mrs N. A. Baduge, BA (Cey.) Mrs H. S. Weeraman *Mrs M. G. -M. M. Neelaweera Mrs L. Wanigatunga Mrs W. C. M. Kuruppu Miss N. M. M. de Costa Miss H. V. Kumudini Mrs S. I. Yapa Miss D. M. K. L. K. Daundasekera Miss S. C. Gallage Miss W. K. C. Nalanie Miss H. K. D. C. S. Jayawardene Mrs D. I. R. Denawaka W. D. Dharmasena K. M. U. Mitranande P. H. Sarath Kumara M. D. C. Seneviratne T. A. S. Siriwardene C. N. Wickremasinghe D. P. Wettasinghe
Instrument Technicians	—	Miss K. C. S. Dissanayake Miss A. B. Furlong L. G. Piyasena Lelwala
Specification Assistant (Special Grade)	—	W. A. S. Wijesekera
Specification Assistance	—	G. Wanigatunga P. D. J. Rodrigo K. K. Austin B. Gunasiri W. W. Nandasena K. R. N. Karunatilleke ***M. A. Mendis
Clerk/Stores Assistant	—	Mrs L. Rukmanie
Clerk/Typists	—	Mrs D. T. Dantanarayana Mrs S. A. Paranawithana Mrs I. Wijesinghe

Biometry Section

Biometrician	—	W. N. Wickremasinghe, BSc (Cey.), Dip. Stat. (Cey.), MSc (Iowa State)
Programmer/Systems Analyst	—	A. R. Weerasinghe, BSc (Cey.)
Senior Technical Officer	—	L. T. Peiris
Technical Officers	—	Miss J. D. Nandanie R. A. P. Abhayapala L. P. P. Vitharana T. B. Dissanayake

Director's Office

Assistant Agricultural Economists	—	H. Talgaswatte, BAgrSc (Cey.) Sumeda de Silva, BAgrSc (Cey.)

ADMINISTRATION DEPARTMENT

Chief Administrative Officer & Secretary to the Board	—	B. S. Ratnayake, BA (Cey.)
Assistant Administrative Officer	—	T. H. Wijesena
Chief Clerk & Personal Assistant to the Acting Director	—	J. D. Gunaratne
Clerk (Special Grade)	—	Mrs D. F. Thambawita
Translator/Clerk	—	D. U. Kannangara
Clerk/Typists	—	R. G. D. Sakaraja Mrs R. S. Amarasekera Mrs W. Paul Mrs P. W. Neelamanie
Telephone Operator	—	Mrs P. Edirimanne

Internal Audit Unit

Internal Auditor	—	Mrs W. P. M. de Almeida, Licentiate of ICA
Assistant Internal Auditor	—	N. C. de Silva

Internal Audit Assistants	—	W. Kularatne S. W. S. G. Gunawardene D. E. C. Warnakula

Library

Librarian & Publications Officer	—	Mrs V. S. Jayaratne, BA (Cey.), DLS (Univ. Kelaniya)
Library Asst. & Asst. Publications Officer	—	D. C. Thambawita
Clerk/Typist	—	Mrs R. Amaratunga

Works Section

Works Engineer	—	G. Mahanama
Chief Clerk (Works Section)	—	D. D. D. Adikaram
Transport Officer	—	B. D. Ponnamperuma
Mechanical Foreman	—	W. D. Dharmawardene
Building Foreman	—	K. K. A. S. Kannangara
Electrical Foreman	—	W. D. Ratnasinghe
Clerk/Typists	—	Miss M. Gunawathie Silva Mrs K. P. R. Gunasekera
Mechanical Supervisor	—	S. D. Gunawardene
Charge Hand (Buildings)	—	H. A. Somasiri
Charge Hand (Electrical)	—	J. D. Sirisena

Accounts Department

Acting Accountant	—	R. W. Gunaratne
Accounting Assistant	—	K. G. A. K. Dharmawardene

Book-Keeper	—	D. A. Rajapakse
Graduate Assistants	—	Mrs G. K. Somasiri, BA (Cey.) Mrs K. K. Jagoda, BA (Cey.)
Clerks	—	G. A. Kannangara G. S. Doolwela
Clerk/Typists	—	Mrs C. C. Silva Miss S. Irene Mrs M. Gunawardene Mrs K. Kapuge Mrs K. K. Basnayake Miss M. D. P. Gunasekera
Assistant Store-Keepers	—	P. D. Somadasa P. L. R. A. W. Cooray D. C. P. Pothmitiyage
Cashier	—	D. C. A. D. B. de Silva

ESTATE DEPARTMENT

Estate Superintendent	—	L. R. Dahanayake
Chief Clerk	—	A. A. Ariyaratne
Acting Senior Assistant Clerk	—	K. K. P. Gunawardene
Junior Assistant Clerks	—	K. D. Sumanasena Miss T. H. C. Silva
Rubber Factory Officer	—	D. S. K. Ranaweera
Rubber Factory Supervisor	—	W. D. D. Senanayake
Field Officers	—	N. L. D. Piyadasa A. K. D. Hemapala S. K. S. de Silva H. M. J. Premalal
Assistant Field Officers	—	J. A. Wimalasena A. K. D. M. Wickremasinghe
Field Supervisors	—	S. R. Vadivel T. Somaratne

Kuruwita Sub-station

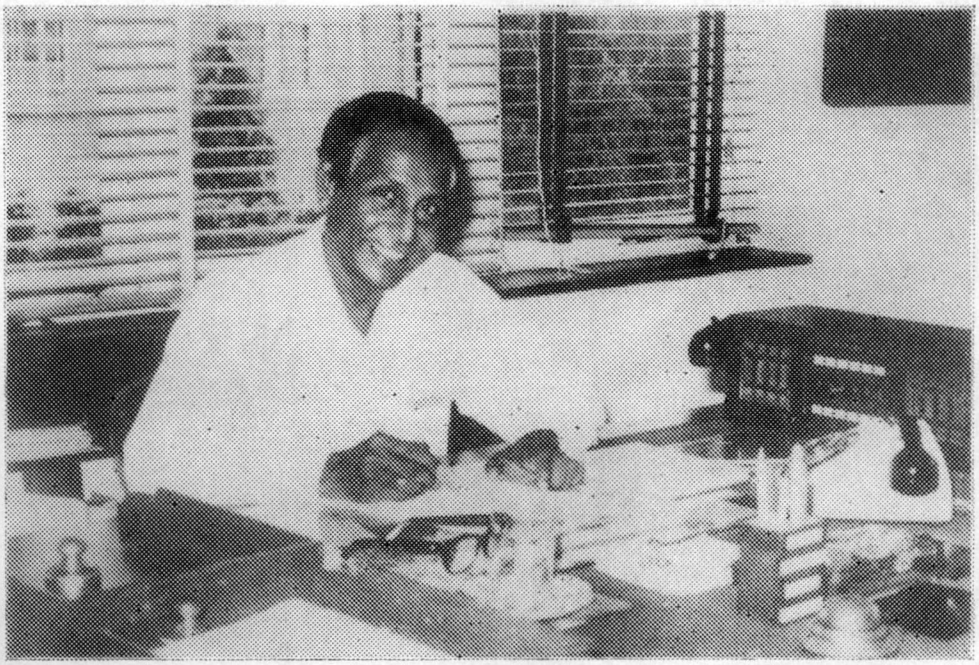
Visiting Superintendent — R. C. Peries

Assistant Estate Superintendent — S. A. R. Samarasekera

* On study leave overseas

** On sabbatical leave overseas

*** On no pay leave overseas



RETIREMENT

Dr Osmund S. Peries retired from the post of Director of the Rubber Research Institute on 30 April 1986 after serving the organization for 32 years, 17 of them as Director during the period 1968 to 1985.

He obtained a degree in Agriculture from the University of Melbourne and joined the Institute in 1954 as Technical Assistant to the then Director, Dr H. E. Young. After obtaining a PhD from the University of Bristol in UK he rose to the position of the Head of Plant Pathology Department. He left the Institute in 1967 and for a short period he held the chair of Botany at the University of Sri Jayewardenepura but re-joined the Institute in 1968 as the Additional Director (Research), and was appointed Director in January 1969.

During his period in office as Director of the Institute he achieved much in terms of staff development so that by his retirement the number of staff with PhD's had increased from 3 to 15.

His was a challenging job and his diligence and enthusiasm enabled him to meet these challenges effectively and efficiently.

In 1980 Dr Peries won the Presidential Award for Scientific achievement and in 1983 he won the FAO Ceres Medal for outstanding contributions to research in Agriculture. In 1985 he won a merit award from the Plastics and Rubber Institute, Sri Lanka for his personal contributions to the Rubber Industry.

He has published over 100 scientific papers, most of them on the pathological problems of the rubber tree, and his research on plant diseases has made him an internationally recognised expert in Plant Pathology.

His constant correspondence with the Research Staff even after leaving the Institute is ample testimony of his keeness to keep in touch with the strong, stable and efficient operation in the Institute which he has developed and nurtured over the years.

We wish him good luck in retirement and in his present assignment as Technical Adviser to the Vietnamese Government on the cultivation of rubber.

THE RUBBER RESEARCH INSTITUTE OF SRI LANKA

ACTING DIRECTOR'S REVIEW

By

S. W. KARUNARATNE

General

The main thrusts of Research and Development activities at the Rubber Researh Institute are

(1) To develop and intensify measures for raising productivity of natural rubber and towards reducing cost of production.

(2) To ensure speedy and effective transfer of research innovations particularly to smallholders.

(3) To continually upgrade the technical quality of natural rubber to meet the increasingly stringent consumer requirements.

(4) Diversification into specialized markets.

(5) Increasing end use applications and catalysing rubber based industries.

Widening the genetic base

One of the most important activities undertaken by the NR industry in recent years, under the auspices of the International Rubber Research and Development Board has been to establish new types of 'Germplasm' in order to widen the genetic base of *Hevea*, thereby in due course it will be possible to produce rubber trees with improved productivity and various other desirable features. The entire plantation in Asia and Africa were started from some 22 seedlings derived from a single collection made over 100 years ago, and it would be incredible if the much wider-ranging activity now in progress in Sri Lanka and all the other major rubber producing countries were not to produce trees with characteristics greatly superior to the present generation.

Plant breeding

In the 1974 multilateral clone exchange programme several RRIC 100 series clones were tested and yield records are available for two years.

In Malaysia these clones were planted in two experimental stations. In terms of yield RRIC 100 series clones, except RRIC 103, gave consistantly high yields in both trials. Yields expressed as kg per hectare per year show RRIC 110, RRIC 100 and RRIC 102 to give respectively: 188%' 175% 148% of the mean yield of the control clone RRIM 600.

The percentage tappability in the first trial was RRIC 110 (71%) RRIC 100 (69%) and RRIC 102 (68%).

In the second trial, the percentage tappability was RRIC 100 (94%) RRIC 102 (91%) and RRIC 110 (90%).

Similar results were obtained in the trials conducted in Indonesia and Thailand.

These clones are all high yielding and will come into bearing at least one year ahead of other clones, given the maximum inputs such as fertilizer and other aids.

These clones have produced yields of 3000 kg. per hectare in experimental conditions and under field conditions has the potential to produce upto 2500 kg. per hectare.

Improved tapping systems

Exploitation of *Hevea* involves both tapping and stimulation of the tree and the ideal exploitation system is the one which gives the highest yields at the lowest cost with the best growth, and bark renewal and the lowest incidence of dry trees. Tapping costs form a large component of the cost of production. Investigations have therefore been carried out through the years in establishing the right tapping frequency and intensity in relation to genetic performance of planting meterial. Arising from these efforts various tapping systems are advocated depending on the planting material.

Disease control

The rubber tree is susceptible to a number of leaf, bark and root diseases. The studies carried out by the RRI, and the clones bred by it, which are mainly tolerant to many of the leaf diseases, have reduced the expenditure on disease control to a minimum. *Oidium* leaf disease, which affects the young leaves first after wintering each year is a fungal disease. The presently recommended clones are largely tolerant to *Oidium* leaf disease at low elevations, so that the RRI has recommended that routine control measures are not necessary at elevations below 100 metres against this disease but may be necessary at higher elevations depending on the weather conditions at the time of refoliation in Sri Lanka. *Colletotrichum* leaf disease causes concern only in young plantations, but has not been a serious problem up to date. *Phytophthora* leaf disease occurs mainly in the south west monsoon season, when there are pods infected by this fungus on the trees. The RRI has been able to keep this disease at minimal levels by the judicious approach to *Oidium* leaf disease control. The *Oidium* fungus affects flower

too, and by eliminating the use of fungicides for *Oidium* control, the fungus has been allowed free reign on the flowers, thus reducing pod set, essential for the growth of the *Phytophthora* fungus which causes mature leaf fall. Therefore, in view of the restricted appearance of pods, the severity of *Phytophthora* leaf fall has been minimal over the years, thus saving the industry a great deal of money on disease control.

For the first time in Sri Lanka, *Corynespora* leaf disease has been identified in a few clearings, both mature and immature, in clone RRIC 103. The disease was very severe in some clearings and a decision was made to avoid utilising RRIC 103 for bud grafting in future. RRIC 103 is now removed from the list of recommended clones.

Rubber trees are susceptible to one major bark disease, also caused by the fungus *Phytophthora*, here again the new clones recommended by us are largely tolerant to the disease, and the control measures devised by us have been quite successful. At the earliest signs of the disease, the trees are scraped clean of the infected bark and the resultant wounds are treated with one of several fungicides, recommended by the Institute. Control measures have been very successfully carried out.

The answer to successful control of white root disease caused by *Rigidoporus* fungus is care at the time of uprooting the old stand for replanting. The most important step in the control of this disease is to ensure a clean, disease free soil at the time the new plants are planted in the field. This can be done at minimal cost by vigilance at the time of uprooting the old stand, marking infected old trees and paying special attention to these sites. This method of prophylactic action has brought down the incidence of white root disease in replanted areas from 10% to below 5% in the period 1978 to 1985.

The RRI has always kept disease control costs well in mind, when recommending control measures against any diseases to the rubber tree.

Soils and plant nutrition

The RRI has perfected the use of the technique of soil and foliar analysis for the recommendation of fertilizers for mature rubber. This method economises on the use of fertilizers as only the required amount of NPK or Mg is applied. The new technique has not only reduced expenditure on fertilizers, but has increased yields by eliminating the possibility of toxicity, of one or more elements by the application of an excess of it.

Fertilizers are the costliest input for crop production, and a rationalization of its use by the technique adopted by the RRI is very important. This technique is now being extended to the smallholders too.

This technique of judicious fertilizer use has saved the industry millions of rupees every year from the time of its introduction.

Relatively inexpensive and isotope aided methods have been developed, to study the nutrition, physiology and biochemistry of the rubber tree. When these experiments are completed, we will be equipped with valuable fundamental information regarding how resources are allocated within the rubber tree.

Biological fixation of nitrogen

Methods are being developed to inoculate leguminous covers with strains of rhizobia to improve their ability to fix atmospheric nitrogen. We are selecting special exotic strains of rhizobia which will compete successfully with indigenous species and contribute to the nitrogen supply of plants.

Rubber Chemistry and Technology

Research into the use of new chemicals in raw rubber manufacture paved the way to the popularisation of an alternative bleaching agent when xylyl mercaptan went out of the market. Further active research in this area resulted in the development of a water soluble bleaching agent which is now widely used by the industry.

The development of DPNR with Ash and Nitrogen values less than 0.1 and its production in commercial quantities is a significant achievement. Its low heat build up, low affinity to water and low rates of creep and stress relaxation make it an ideal rubber for applications ranging from air craft tyres to off shore engineering.

We have assisted and continue to assist the local industrialists to develop rubber products for the export market. We would like to see more enthusiasm among the rubber products manufacturers to come forward and make use of the R & D facilities that are available to them.

What we seek to establish is a closer liaison between the research institute and the industry. Industry gains by having access to the stronger academic back ground of the scientists and the scientists in turn gain knowledge of the industrial processes and techniques.

Training

The Rubber Research Institute has been in the fore front in the training of resource personnel for the industry at all levels. We give the fullest assistance to the Universities to conduct undergraduate, postgraduate and technicians courses in Rubber Technology and the Chemistry and Technology of polymers. Most of the MSc projects dealing with polymers are supervised by our staff and this has been a continuing feature for the last 15 years. We are proud that resource personnel trained by us, are occupying positions at all levels in the industry whether it be top management, middle management or technician level. We are also having our regular programmes to train Estate Superintendents, the Supervisory Staff and the Extension Officers in all aspects of rubber culture and processing and to keep them informed of the latest research innovations.

STAFF

Dr O. S. Peries retired from the post of Director on 30 April 1986 and Mr S. W. Karunaratne, Head Rubber Chemistry Department was made the Acting Director from 1 May to 31 December 1986. The Heads of Departments and all Senior and Intermediate Staff Officers were on duty throughout the year, except where reference is made below.

Dr A. de S. Liyanage, Deputy Director (Research) and Head of Plant Pathology Department proceeded to Imperial College of Science & Technology, UK on the 14 January on a fellowship awarded by the Royal Society of U.K. and returned to the Island on the 20 November. He then left to Indonesia to attend the National Rubber Conference, as a guest speaker. Thereafter he served as a consultant to the Estates Crop Research Institute, Bogor, Indonesia, for one month and returned to Sri Lanka on the 30 December.

Mr S. W. Karunaratne, Head of Rubber Chemistry Dept. and the Acting Director attended an Expert Advisory Group meeting on Radiation Vulcanization of NR latex from 1–3 September in Takasaki, Japan. He also attended the ISO/TC 45 meeting on Rubber and Rubber Products held in Moscow, U.S.S.R. from 11 to 18 September.

Dr (Mrs) A. C. I. Samaranayake, Head of Plant Science Dept. attended the Plant Physiology and Exploitation Conference in Hainan, China from 5 to 11 December.

Dr P. A. J. Yapa, Head of Biochemistry Section attended a Conference on Control of Environmental Pollution in Malaysia from 16 to 25 November.

Dr N. E. M. Jayasekera, Head of Genetics and Plant Breeding Dept. attended the I.R.R.D.B. Plant Breeders meeting in Goa, India from 27 October to 1 November.

Dr A. Coomarasamy, Head of Polymer Chemistry Section was away for 9 months till 25 January carrying out research on Natural Rubber Composites at the M.R.P.R.A. U.K.

Dr L. M. K. Tillekeratne, Head of Specifications and Analysis Section attended a Workshop in Paris and Ivory Coast from 18 to 31 January. He is now on sabbatical at Aston University on a fellowship awarded by the Royal Society of United Kingdom for one year from the 9 November.

Dr M. K. S. A. Samaraweera, Agricultural Chemist was away in Australia on sabbatical leave on an I.A.E.A. Fellowship till 7 October and thereafter on 2 months no pay leave.

Dr P. A. D. T. Vimalasiri, Asst. Specifications Officer resumed duties on 30 July having completed a course of training in Chemistry and Technology of Polymer Processing at the University of South Wales, Australia.

Miss N. M. V. Kalyani, Asst. Rubber Chemist is continuing her studies on Latex Technology leading to the PhD degree at the London School of Polymer Science, U.K

Mr C. K. Jayasinghe, Asst. Plant Pathologist was in Australia for 6 months at the University of Western Australia to complete the PhD. thesis.

Mr M. D. R. J. Goonetilleke, Asst. Rubber Chemist is continuing his studies in Chemical Engineering with special reference to Tyre Technology leading to the PhD degree at the University of Aston in U.K.

Mr R. C. W. M. R. Asoka Nugawela, Asst. Botanist returned to the Island in October having done part of the work for his PhD. on a split scheme, in Photosynthesis and Bio-Productivity at the University of Essex, U.K.

Mrs N. I. S. Liyanage, Asst. Plant Pathologist was continuing her studies leading to the PhD. degree in Plant Pathology at the Imperial College of Science and Technology, U.K.

Mr W. M. G. Seneviratne, Asst. Rubber Chemist left for U.K. in October to follow a course of training under the Agricultural Research Project leading to the PhD degree.

Miss S. A. P. P. Sirimanne, Asst. Rubber Chemist left for U.K. in October to follow a course of training under the Agricultural Research Project leading to the PhD degree.

Mrs S. C. Dharmaratne, Asst. Geneticist and Plant Breeder left for Scotland in October to follow a course of training under the Agricultural Research Project leading to the PhD. degree.

Mr E. D. I. H. Perera, Asst. Rubber Chemist is continuing his studies in Chemical Engineering on Alternative Energies at the University of Reading, U.K., leading to the PhD. degree.

Mrs M. L. A. Samarappuli, Asst. Soils Chemist left for U.S.A. on 2 April to follow a course of training in Soil Moisture at the University of California.

Mr W. A. D. D. S. Wettasinghe, Senior Technical Officer of the Plant Patholgy Dept. resumed duties having followed a training course in Nitrogen Fixation at the University of Western Australia.

Mr E. B. Fernando, Technical Officer of the Plant Pathology Dept. returned to the Island on 23 March having followed a course of training in South American leaf blight and its control measures in Brazil.

Mrs M. G. M. M. Neelaweera, Technical Officer of the Rubber Chemistry Dept. is following a training course in Rubber Technology at the R.A.P.R.A. Technology Ltd., U.K.

Mrs P. C. Wettasinghe, Technica Officer of the Plant Pathology Dept. was away in Australia for six months on no pay leave.

Mr M. A. Mendis, Specification Assistant, Rubber Chemistry Dept. continued his no pay leave assignment in Saudi Arabia.

The salaried staff of the Institute at the end of the year (1986) was as follows:

Officers in Grade I — VI —	45
Officers in Grade VII — XV —	138
Officers in Grade XVI — XIX —	92
Total	275

VISITORS

Visitors to the Institute included

Miss Janet Riley, Overseas Development Administration, U.K.
Mr John King, Overseas Development Administration, U.K.
Mr Jonathan Crowe, Twyford Laboratories, U.K.
Mr P.M. Room, CSIRI, Australia.
Mr Pham Van Vinh, RRI, Vietnam.
Dr S. Hirashima, Institute of Developing Economics, Tokyo.
Dr Rogar Taylor, University of Reading, U.K.
Mrs Rogar Taylor, U.K.
Mr Jonatha Anderson, University of Exeter, U.K.
Mrs Tang Rui Fang, Beijing, China.
Mr Pedritd V. Santiago, SGV Group, Philippines.
Mr Meadows, World Bank.
Dr Alias Husin, Fertilizer Marketing Department, Malaysia.

REVIEW OF THE PLANT SCIENCE DEPARTMENT

By

CHANDRA SAMARANAYAKE

SUMMARY

Shoot tip explants were successfully established in culture and induction of proliferation of buds and rooting was achieved during the year. However, the growth of new shoots from proliferated buds was slow.

Tree girths ranging from 40.0–50.0 cm showed no significant effect on yield of puncture tapped trees, where as yield of conventional excision tapping was significantly increased with increase in tree girth. Puncture tapping yields have been significantly lower than yields from conventional tapping and this method (puncture tapping) will have only a limited application under our conditions.

Studies on leaf gas exchange rates and related characters of five clones, with varying yield potentials, have indicated the possibility of predicting yield potentials using these parameters.

DETAILED REVIEW

Staff

The Head of Department Dr (Mrs) A. C. I. Samaranayake was on duty throughout the year. She acted for the Head, of Plant Pathology Department from 15 August — 31 December. Mr A. Nugawela, Assistant Botanist returned to the Department on 25 October, after completing the first phase of his PhD programme, at the University of Essex, England. Miss G. P. W. P. Pushpika and Miss M. S. Ranasinghe, Assistant Botanists were on duty throughout the year. Mr V. H. L. Rodrigo, joined the Department as an Assistant Botanist on 1986.10.01.

Messrs L. S. S. Pathirane and R. B. Gunaratne, Experimental Officers, Messrs S. Wilbert and U. K. D. Lewis, Experimental Assistants, Messrs L. S. Kariyawasam, K. A. G. B. Amaratunge, R. P. Karunasena, U. S. Weerakoon, S. L. G. Ranjith, R. S. Wijesundera, Miss C. W. Ranasinghe, Miss G. A. S. Wijesekera and Miss R. K. Aluthhewage, Technical Officers and Miss D. E. Jayasekera Clerk/Typist were on duty throughout the year.

Mr A. G. Vidanapathirana, Technical Officer resigned his post on 1986.01.13.

Miss I. G. Gunetilleke, Temporary Research Assistant continued her studies in the Department.

Visits

Chandra Samaranayake attended the Physiology and Exploitation Physiology Group Meeting of the IRRDB held at the South China Academy of Tropical Crops, Hainan, Guandong, China from 1 — 14 December.

Department staff made advisory visits to plantations and made regular visits to experimental areas.

Staff of the Nursery Inspection Unit inspected all nurseries supplying plants to the Smallholder Rubber Rehabilitation Project to ensure quality of plant material supplied by them.

All stock seedling and budwood multiplication nurseries registered with the Rubber Control Department were inspected before the nurseries were permitted to sell plants.

Meetings

Chandra Samaranayake addressed the Sri Lanka State Plantation Corporation (SLSPC) Board IV, Planters' Conference on "The Use of Yield Stimulants".

Chandra Samaranayake and G. P. W. Priyani Pushpika participated in the meeting of the Tissue Culture Group and the Symposium on Tissue Culture at the SLAAS, Colombo.

Training

Department Staff were involved in the following training programmes during the year.

Diploma in Plantation Management, conducted by the National Institute of Plantation Management.

Training course for Assistant Rubber Controllers of the Rubber Control Department.

Refresher courses for Rubber Extension Assistants of the Advisory Services Department.

Training courses on tapping for smallholders.

Training courses on budgrafting.

Publications

Long, S. P., Nugawela, A., Bongi, G. and Farrage, P. K. (1986). Chilling dependent photoinhibition of photosynthetic CO_2 uptake. *Proc. Int. Photosyn. Conf.* 1986, *USA.*

Samaranayake Chandra, Pushpika Priyani, Gunetilleke Irangani and Wijesekera, Sunitha (1986). Clonal propagation of *Hevea* through Tissue Culture. *Symposium on Tissue Culture for Developing Countries its uses and potentiols: SLAAS, Colombo.*

Samaranayake, Chandra, (1985). Plant growth substances in Agriculture. *Bull. Rubb. Res. Inst. Sri Lanka,* **20 & 21**, 25 - 27.

Advisory Circulars

Tapping of *Hevea* - For the Advisory Services Department.

Reports

Annual Review of the Plant Science Department.

Laboratory Investigations

Tissue Culture

Different methods of cleaning of explants were tested and a method was developed by which a fair number of explants, free of contaminats could be obtained. Techniques were developed to successfully establish both seedling and clonal explants in aseptic culture. Induction of bud proliferation was achieved. However the growth of buds were either very slow or could not be induced. With certain modifications to the culture medium root development could be induced in young shoots. The roots developed were similar to tap roots. (Chandra Samaranayake, Priyani Pushpika, Irangani Gunatilleke and Sunitha Wijesekera)

Gas exchange studies

The objective of this study is to determine whether gas exchange rates and related parameters could be used in screening new *Hevea* genotypes for yield, at an early stage of growth. Six to eight month old buddings of clone RRIC 45, 100, 103, PB 86 and IAN 710 were used in this study.

Gas exchange capacities

Differental CO_2 measurements were done to determine CO_2 assimilation (A), dark respiration (Rd) and Photorespiration (Rp) rates in the laboratory, differences in A and Rp were highly significant.

Transpiration and water use efficiency

Transpiration rates (E) and leaf diffusive resistance for water vapour (D_r) were measured in the field using a Li-Cor, Li-1600 steady state porometer. Water use efficiency (A/E) of genotypes were calculated. Significant differences among clones were observed.

Related anatomical studies

Average size of a trifoliate leaf and the total leaf area in a single whorl of leaves were measured. Stomatal densities were studied using silicone rubber imprint method. There were significant clonal differences in the parameters studied.

This study indicated that a single clonal character does not show a significant correlation with the yield potential of the corresponding clone. A parameter calculated using A, Rp, La and A/E of the clones studied showed a highly significant correlation with the yield potential.

Effect of tapping on A

Initial studies using one year old seedlings failed to show any effect of extraction of latex on A.

Partitioning of assimilates

Growth analysis of plants of the same clones were done to compare rates of dry matter production and its partitioning to different components of the plant. (A. Nugawela and R. K. Aluthhewage)

Studies on phenolic compounds accumulating in tissue culture media

Preliminary studies on accumulation of phenolic compounds in culture media of *Hevea* shoot tip explants were carried out. (M. S. Ranasinghe)

Studies on latex physiology

Studies were commenced on serum sucrose levels to study whether the sucrose level can be used as an indicator to evaluate the response of clones to different intensities of tapping. Sucrose level of different clones subjected to the same intensity of tapping and the same clone tapped on different intensities were studied. (M. S. Ranasinghe and L. S. Kariyawasam)

Tapping

PB 86, 1974 *replantation, Eladuwa* (*T*/81/1)

This experiment was started in 1981 to compare puncture tapping (PT) with the conventional tapping (CT) under commercial conditions. After completion of 2 years, puncture tapping was discontinued and conventional tapping was started on all puncture tapped trees and were tapped on the $\frac{1}{2}$S d/2 system. Before the commencement of the experiment in 1981, girth of all trees was recorded. After introducing conventional tapping in 1983, 5 PT trees and 5 CT trees from each of the girth classes were selected and test tapped to study the effect of PT on future yield and growth of trees.

Results recorded in 1986 are summarised in Table 1.

Table 1. *Mean yield* (*g/t/t*) *and girth increment* (*cm*) *in* (*T*/81/1)

Treatment			Yield (g/t/t)	Girth (cm) increment
T_1 Less than 45.00 cm previously untapped			—	—
T_2 45.0 — 49.9 cm previously		PT	23.016	0.160
T_3 45.0 — 49.9 cm	,,	CT	19.987	0.500
T_4 50.0 — 54.9 cm	,,	PT	27.438	0.300
T_5 50.0 — 54.9 cm	,,	CT	25.810	0.400
T_6 Greater than 55 cm	,,	PT	40.266	1.620
T_7 Greater than 55 cm	,,	CT	37.607	3.233
T_8 Less than 45.0 cm	,,	PT	15.720	1.25
LSD .05			13.04	1.843

(T_1 was removed as all the trees in this treatment developed brown bast)

There was a significantly higher yield from previously PT trees compared to CT trees, in 1984. In 1985, only the trees of girth class 50.0 — 54.9 gave a significantly higher yield with previously PT trees compared to CT trees. In 1986 there was no significant difference in yield of previously PT trees and CT trees in any of the girth classes. There was no significant difference in the girth increment between PT and CT trees. (Chandra Samaranayake and R. P. Karunasena)

PB 86, 1978 *replantation, Urumiwela* (*T*/84/3)

This experiment was set down to investigate whether economic yields could be obtained by commencing tapping, at heights above the recommended level and tapping higher panels upwards before normal base panels. All treatments were tapped on ½S d/2 tapping system.

Results recorded for 1986 are summarised in Table 2.

Table 2. *Mean yield (g/t/t) of different heights of tappjng* (*T*/84/3)

Treatment	Yield (g/t/t)
a. Tapping cut marked at 105 cm height	21.8
b. Tapping cut marked at 120 cm height	20.7
c. Tapping cut marked at 135 cm height tapped upwards	19.5

There was no significant difference in yield due to difference in opening of cuts at different heights or due to the difference in the direction of cut. (Chandra Samaranayake and U.K.D. Lewis)

RRIC 103, 1978 *replantation, Pallegama* (*T*/84/1)

This experiment compares several initial girths for commencement of tapping, for their effect on yield and subsequent girth increase. The following girth classes were included.

T_1 — 40.0 - 44.9 cm girth
T_2 — 45.0 - 49.9 cm girth
T_3 — 50.0 - 54.9 cm girth
T_4 — Greater than 55.0 cm girth

The tapping system was ½S d/3.

The results available so far indicate significantly higher yields with trees of greater girths. (Chandra Samaranayake and R. P. Karunasena)

PB 86 *replantation, Dalkeith* (*T*/84/2)

The purpose of this experiment is to compare several initial girths for commencement of tapping on conventional (CT) and puncture tapping (PT) systems, for their effect on yield and subsequent girth increase. The following treatments were included.

Tapping systems — ½S d/2
6Pg/100 (0.5) d/2 + Ethrel Stimulation

Girth classes T_1 — 40.0 - 44.9 cm girth
T_2 — 45.0 - 49.9 cm girth
T_3 — 50.0 - 54.9 cm girth
T_4 — Greater than 55 cm girth

Results recorded for 1986 are summarised in Table 3.

Table 3. *Mean yield of different girth classes*

Treatments	Yield (Kg/ha)	
	CT	PT
T_1	886	755
T_2	1130	876
T_3	1300	898
T_4	1510	879
LSD	164.7	

In each girth class, CT has given significantly higher yields compared to PT. There is a significant increase in yield with increase in girth of trees in CT treatments. In PT there is no significant difference in yield between different girth classes. (Chandra Samaranayake and S. Wilbert)

High intensity tapping during the last few years of a plantation, Frocester (*IS*/84/1), (*IS*/84/2) *Nakiadeniya* (*IS*/84/3), (*IS*/84/3) *and Ambadeniya* (*IS*/84/6)

The objective of these experiments is to investigate suitable systems of high intensity tapping during the last few years of a plantation, to obtain maximum possible yields.

Results recorded for (IS/84/1) and (IS/84/3) are summarised in Table 4.

Table 4. *Mean yield (Kg/t/t) for different treatments in* (*IS*/84/1) *and* (*IS*/84/3)

Treatments	IS/84/1			IS/84/3		
	1984	1985	1986	1984	1985	1986
1. $\frac{1}{2}$S + 1/4S* ($\downarrow\uparrow$) d/3	9.19	6.83	5.21	12.70	7.02	6.71
2. $\frac{1}{2}$S + V ($\downarrow\uparrow$) d/3	8.64	6.66	5.26	12.96	7.00	6.38
3. $\frac{1}{2}$S + $\frac{1}{2}$S ($\downarrow\uparrow$) d/3	10.51	7.85	5.58	11.70	6.62	6.21
4. $\frac{1}{2}$S + $\frac{1}{4}$S ($\downarrow\uparrow$) d/3	7.85	6.78	5.40	11.34	6.64	6.18

* 5% ET, Ba 0.8 (2.5) 4/y

There were significant differences in yield between treatments in the first year. In the second and third years of tapping, there were no significant differences in yield between the different tapping systems. Stimulated $\frac{1}{4}$S cuts tapped upwards gave significiantly higher yields than the unstimulated upward $\frac{1}{4}$S cuts only during the first year, suggesting a decline in response to ethrel stimulation. There was a significant yield difference between the upward $\frac{1}{2}$S cut and V cut in the first year which was not observed since then.

The results recorded so far for experiments (IS/84/2), (IS/84/4) and (IS/84/6) are summarised in Table 5.

Table 5. *Mean yield (kg/t/t) for different treatments in (IS/84/2), (IS/84/4) and (IS/84/6)*

Treatments	Mean yield (kg/t/t)						
	IS/84/2			IS/84/6		IS/84/4	
	1984	1985	1986	1985	1986	1985	1986
1. V* d/2↗	6.75	4.95	4.61	10.48	8.65	7.77	6.74
2. ½S* d/2 (↑)	6.31	4.64	4.44	9.80	7.12	7.87	6.68
3. ½S+¼S (↓ ↑) d/2	6.15	4.66	4.66	9.52	7.63	8.28	7.61
4. ½S+**PT(↓ ↑) d/2	6.62	4.93	4.51	7.24	6.05	8.73	7.93

* 5% ET Ba 0.8(2.5) 4/y

** 5% ET Ba 1.0 2W

There were significant differences in yield between different treatments only in experiment IS/84/6. In other experiments all treatments gave similar yields, although tapped at different tapping intensities. Lower intensity tapping systems (Treatments 1 and 2) gave yields comparable to other high intensity tapping systems.

In all treatments there was a significant decline in yield each year. To arrest this decline tapping intensity was increased with more frequent stimulation. (A. Nugawela, Chandra Samaranayake, S. Wilbert and R. P. Karunasena)

Interaction of clones and tapping systems St. George (CT/77/3)

The purpose of this experiment was to ascertain the most effective tapping systems for different clones. The four tapping systems tested, on 15 clones, are as follows:

1. ½S d/3
2. ½S d/2
3. ½S d/2 with provision for changing over of panels for introducing extra cuts.
4. ½S d/2 for 3 months and Pg/100 (0.5) d/2 + E for 4 months

The yield data for 1986 indicate no significant clone and tapping interaction. Puncture tapping yields were significantly lower than conventional tappings. (Chandra Samaranayake, L. S. S. Pathiratne and Charlotte Ranasinghe)

Brown bast

RRIC 101, 1976 *replantation, Eladuwa* (*BB*/77/1)

The aim of this experiment was to see whether brown bast can be transmitted through the use of buds removed from brown bast affected trees. Experimental details are given in Ann. Rep. 1983. The incidence of brown bast recorded so far does not give any indication that, brown bast in buddings originating from affected trees, is higher than in normal bud grafts. (Chandra Samaranayake and R. P. Karunasena)

RRIC 101, 1976 *replantation, Eladuwa* (*BB*/77/2)

This experiment was started to see whether high yielding trees are more prone to brown bast and to see whether there is a definite pattern of spread of brown bast in a plantation. Brown bast incidence was recorded at monthly intervals. (Chandra Samaranayake and L. S. Kariyawasam)

Tree spacing and density

Tree spacing and density, Millewa (*CD*/77/1)

Clones RRIC 101, 103 and PB 86 were established at six spacings and densities on a factorial lay out with three replicates in 1977. Yields recorded in 1986 are summarised in Table 6.

Table 6. *Mean yield* (*g/t/t*), (*CD*/77/1)

Spacing (cm)	Density trees/ha	Yield PB 86	RRIC 101	RRIC 103
S_1 2.5 × 10.0	400	35.4	37.2	31.8
S_2 2.5 × 7.5	533	25.9	29.3	33.5
S_3 2.5 × 6.0	666	20.3	28.4	24.3
S_4 2.5 × 5.0	800	30.8	25.7	22.3
S_5 3.87 triangular	771	27.2	31.2	19.0
S_6 3.54 triangular	920	30.9	22.5	24.7
LSD 0.05		6.58		

There was a significant interaction between clones with spacing and density on yield. There are significant differences in yields between S_1 & S_2, S_1 & S_3 but no significant differences betwee S_1 & S_4, S_1 & S_5 and S_1 & S_6 in clone PB86. These differences cannot be explained as a density effect. Clone RRIC 101 gave significantly lower yields with densities more than 400 trees/ha. Clone RRIC 103 gave significantly lower yields with densities more than 533/ha.

Girth measurements recorded in 1986 are summarised in Table 7.

Table 7. *Mean girth (cm) (CD/77/1)*

Clone	S_1	S_2	S_3	S_4	S_5	S_6
PB 86	51.4	56.8	51.5	48.2	53.0	47.9
RRIC 101	65.2	57.1	54.3	53.4	53.0	49.9
RRIC 103	63.5	64.1	54.7	56.4	57.4	54.5
LSD 0.05	4.79					

There was a significant interaction between clones and densities and spacings on girth of trees at 9 years from planting. There was no significant defference in girth of clone PB 86 in different densities from S_1 to S_5. However there was a significant reduction in girth at the highest spacing of 920 trees/ha. In clone RRIC 101 there was a significant reduction in girth when density was increased to 533 trees and in RRIC 103 girth was significantly affected at a density of 660/ha and more. (Chandra Samaranayake, L. S. S. Pathiratne)

Propagation

Stock-scion experiment, St. George (St. sc/75/4)

Clones RRIC 45, 52, PB 86 and Wagga 6278 have been budded on to clonal seedling rootstocks of the same four clones in a diallel design.

Yield and girth data recorded in 1986 did not indicate a significant rootstock effect on yield or growth. (Chandra Samaranayake, K. A. G. B. Amaratunge)

Stock-scion experiment, Frocester (St. sc/80/6)

Clones RRIC 100, 101, 102, 103, 111, and PB 86 have been budded on to seedling rootstocks of the same clone in a diallel design. Growth in girth, measured 6 years from planting, showed only a significant scion effect and no rootstock effect. (Chandra Samaranayake, R. P. Gunaratne, U. S. Weerakoon)

Stock-scion experiment, Moraltoya (St. sc/81/7)

Clone RRIC 100, 101, 103, PB 86 and GT 1 have been budded on to seedling rootstocks of the same clone in a diallel design. Growth in girth at 5 years from planting, showed no significant rootstock effect. (Chandra Samaranayake and L. S. Kariyawasam)

Crown budding

Crown budding experiment, St. George (CB/75/1)

The purpose of this experiment was to study the effect of different crown on growth and yield of the trunk. There was no significant effect of the crown on yield of the trunk in the data recorded in 1986. (Chandra Samaranayake and K. A. G. B. Amaratunge)

Planting techniques

Stumped buddings, Neuchatel (RI/81/3)

Green buddings were compared with stumped buddings in this experiment. Experimental details were given in Ann. Rev. 1984. Green buddings were planted in the field, 13 months ahead of stumped buddings which were planted in the field with 13 months of growth, from the nursery. Growth measurements recorded so far indicated that the growth of budded stumps was superior to that of stumped buddings. (Chandra Samaranayake and K. A. G. B. Amaratunge)

Comparison of planting techniques, Peenkande (GB/79/2)

Several methods of field establishment were compared in this experiment. Experiment details were given in Ann. Rev. 1980. Growth of plants 6 years from planting showed the superiority of budding at stake in the field and polybagged plants to those of bare root stumps. There was no differences in growth of plants between seedlings raised, budded and grown in polybags with budded stumps raised in polybags. There was no significant difference in growth of green buddings and brown buddings. (Chandra Samaranayake and L. S. Kariyawasam)

Brown buddings in polybags, Gallewatte (PB/81/4)

In this experiment budded stumps grown in polybags for 6 months and bare root budded stumps were transplanted in the field at the same time. Growth of plants after 5 years from planting showed that polybag grown plants were superior in growth to bare root plants. (Chandra Samaranayake and S. Wilbert)

Green buddings vs. brown buddings, Geekiyanakande (PB/81/5)

The growth of green and brown bare root stupmps and polybagged buddings were compared after transplanting in the field. The bare root plants which were transplanted in the field, at the time of planting budded stumps in polybags, showed significantly better growth in the field than polybag grown plants transferred to the field 12 months later. (Chandra Samaranayake and K. A. G. B. Amaratunge)

Clone characters

Field obseravations, Eladuwa (CC/77/1)

The purpose of this study was to investigate a number of clones to see whether any criteria could be used in the early selection of clones. Experimental details are given in Ann. Rev. 1980. Recording of individual tree yields were continued in 1985. (Chandra Samaranayake and L. S. Kariyawasam)

Intercropping

Demonstration plots of rubber intercropped with banana were established in two smallholdings in the Kalutara District. (V. H. L. Rodrigo, U. K. D. Lewis and L. S. Kariyawasam)

REVIEW OF THE GENETICS AND PLANT BREEDING DEPARTMENT

By

N. E. M. JAYASEKERA

SUMMARY

Two clones, RRIC 103 and RRIC 104 were removed from recommendations as they were found to be susceptible to *Corynespora* leaf disease. Two selections, 74–141 and 74–157, out of four made from 1974 hand pollination seedlings were discarded as they too were found to be highly susceptible for this disease.

RRIC 121 continued to show its superiority with respect to vigour and high yield potential.

Studies made during 1986 flowering season indicated that in *Hevea* anther dehiscence is completed by 11.00 a.m.

DETAILED REVIEW

Staff

Head of the Department, Dr N. E. M. Jayasekera and Assistant Geneticist and Plant Breeder, Mr D. P. S. T. G. Attanayake were on duty throughout the year.

Mrs S. C. Dharmaratne, Assistant Geneticist and Plant Breeder left for post-graduate studies at Scottish Crop Research Institute, Dundee UK on 18 October 1986.

Mr K. B. Karunasekera, Experimental Officer, Mr K. W. Rupatunge, Senior Technical Officer, Mr B. M. S. G. Peiris, Senior Experimental Assistant, Mr A. K. M. S. Senaratne, Experimental Assistant and Messrs I. D. M. J. Sarathkumara and R. A. S. K. Ranatunga, Technical Officers, were on duty throughout the year.

Visits

The Department staff made regular visits to experimental areas.

Meetings and Conferences

Head of the Department attended four Scientific Committee Meetings held on 14 March, 20 June, 10 October and 12 December 1986.

Head of the Department participated in the SLSPC Galle region rubber planters' meeting held on 12 August and JEDB, Agricultural Advisors' meeting held on 10 November at Talduwa.

Head of the Department also attended the International Rubber Research and Development Board (IRRDB) Plant Breeders, meeting held in Goa, India from 28 to 30 October 1986.

Training

Head of the Department participated, whenever requested, in the training programmes and panel discussions, organised by the Training Centre of the Advisory Services Department, for Rubber Extension Officers.

Head of the Department conducted a lecture on "*Hevea* breeding and recommended planting material" to the planters who followed the Diploma in Plantation Management Course conducted by the National Institute of Plantation Management.

Publications

Jayasekera N. E. M. (1985). Role of quantitative genetics in the improvement of crop yields by controlled breeding. *RRISL Bull.* **20** and **21**, 39 – 42.

Reports

Jayasekera N. E. M. (1985). Annual Review of the Genetics and Plant Breeding Department.

General

A severe attack of *Corynespora* was observed in field clearings of RRIC 103 which has been recommended for large scale planting. RRIC 104, recommended for planting upto 10 hectares, was also found to be susceptible to this leaf disease. Both these clones were removed from the Institute recommendations.

Issues and receipt of budwood

Local

The budwood nurseries at Kuruwita and Nivitigalakele sub stations, maintained by the Department, issued a total of 1938 metres of nucleus budwood to estates and private nurseries. Details are given in Table 1.

Table 1. *Details of issue of budwood*

Clone	Kuruwita	Nivitigalakele
RRIC 100	225	261
RRIC 103	554	101
RRIC 121	613	109
RRIC 110	40	—
RRIC 133	35	—
Total	1467	471

Foreign

Budwood of RRIC 100, RRIC 102, RRIC 103 and RRIC 121 was sent to Agriculture Department of Burma.

Budwood of 950 IRRDB germplasm clones was received during 1986.

Field Experiments

Breeding, selection and clone evaluation

Hand pollination programme for 1986 (*BST/HPS*/86/1)

Hand pollination for 1986 commenced in February at Eladuwa State Plantation and was completed in March. Full crossing programme was not possible due to unexpected rains and subsequent out-break of *Oidium* which affected the flowers and only 6097 pollinations were possible. Detailed break down of the hand pollinations carried out during 1986 flowering season and the seedlings derived are given in Table 2. These pollinations include two interspecific crosses and crosses made in attempt to study the various aspects of reproductive biology under FBH/86/1. Two pods were derived from the interspecific cross between *Hevea brasiliensis* and *Hevea nitida* but non of the seeds germinated. (N. E. M. Jayasekera, D. P. S. T. G. Attanayake, A. K. M. S. Senaratne, K. W. Rupatunga)

Table 2. *Crosses, number of pollinations and seedlings derived from* 1986 *hand pollination programme*

Cross	No. of pollinations	No. of seedlings
PB 86 X RRIM 600	555	9
PB 86 X RRIC 100	163	3
RRIC 102 X RRIC 118	1913	5
RRIC 100 X PB 86	275	8
RRIC 101 X PB 86	443	59
RRIC 104 X PB 86	775	15
RRIC 100 X RRIC 102	108	0
RRIC 102 X RRIC 100	819	0
RRIC 102 X PR 306	156	0
RRIC 102 X RRIC 600	50	0
PB 86 X RRIC 102	150	0
RRIC 102 X PB 86	600	0
H. brasiliensis X *H. nitida*	40	0
H. spruceana X *H. nitida*	50	3
Total	6097	102

Floral biology of Hevea (*FBH*/86/2)

During 1986 flowering season following aspects of *Hevea floral* biology were studied. (D. P. S. T. G. Attanayake, A. K. M. S. Senaratne, K. W. Rupatunga)

Comparison of natural fruit set and fruit set following hand pollination, using RRIC 102 *as the mother parent* : Female flowers of RRIC 102 were tagged to study the natural fruit set. The observations made are given in Table 3.

Table 3. *Observation made three months after pollination, on natural fruit set of RRIC* 102

Tree	No. of flowers tagged	No. of fruits
1	1718	10
2	1056	9
3	1256	5

Female flowers of RRIC 102 were pollinated with pollen of five other clones to determine the success of fruit set following artificial hand pollinations. Results are presented in Table 4.

Table 4. *Fruit set following hand pollination of female flowers of RRIC* 102

Cross	No. of pollinations	Fruit set
RRIC 102 X RRIC 118	1913	3
RRIC 102 X RRIC 100	50	0
RRIC 102 X RRIM 600	819	0
RRIC 102 X PR 306	156	0

Stigma receptivity: Female flowers of 5 clones were pollinated at 2 hour intervals starting from 7.30 a.m. upto 3.30 p.m. Anthers dehisced on the same day were used except for the female flowers that were pollinated at 7.30 a.m. This was unavoidable as anthers usually dehisce after 9.30 a.m. Anthers dehisced on the previous day had to be stored in a refrigerator to be used in 7.30 a.m. pollinations. The crosses, number of pollinations done at each time and the number of fruit set are given in Table 5.

Table 5. *Crosses, number of pollinations and number of fruits set, recorded after three months, at each time of pollination.*

Cross	No. of pollinations at each time	No. of fruits set at each time of pollination				
		a.m.			p.m.	
		7.30	9.30	11.30	1.30	3.30
PB 86 X RRIC 102	30	0	0	0	0	0
RRIC 102 X PB 86	120	0	0	0	0	0
RRIC 100 X PB 86	55	1	0	0	3	0
RRIC 101 X PB 86	85	2	2	10	3	2
RRIC 104 X PB 86	155	13	26	23	17	4

Time of anther dehiscence : The three clones viz RRIC 100, RRIC 101 and RRIC 102 were observed for time of anther dehiscence at 30 minutes intervals from 6.30 a.m. Since male flowers opened around 9.30 a.m. early morning observations were made on unopened flowers that were to open later in the day. At each time 20 male flowers were selected at random and observed under a field magnifying glass for dehisced anthers. Since flowers were harvested for the observation, a new set of 20 flowers had to be observed at each observing time. Data in summarised form are given in Table 6.

Table 6. *Data collected on time of anther dehiscence in* Hevea

Time of observation	No. of flower buds examined	No. of buds showing dehisced anthers in each clone		
		RRIC 100	RRIC 101	RRIC 102
6.30 a.m.	20	0	0	0
7.00 a.m.	20	0	0	0
7.30 a.m.	20	0	0	0
8.00 a.m.	20	0	0	0
8.30 a.m.	20	0	0	0
9.00 a.m.	20	0	0	0
9.30 a.m.	20	16	2	2
10.00 a.m.	20	19	11	8
10.30 a.m.	20	19	20	14
11.00 a.m.	20	20	20	20
11.30 a.m.	20	20	20	20
12.00 noon	20	20	20	20

It is seen from the table that anther dehiscence, in all three clones under observation, started around 9.30 a.m. and was completed by 11.00 a.m.

Insect visitors to Hevea *flowers* : Total number of 66 hours were spent in observing and collecting the insects that visited *Hevea* flowers, to identifying the probable insect pollinators. Two most common types were sent to the Commonwealth Institute of Entomology for identification and were identified as *Stomorina discolor* and *Drosophila sp.*

Functional male to female flower ratio in Hevea *clones*: Tagged inflorescences of four clones were studied for functional male to female flower ratio. Only opened male and female flowers were counted for computing the ratios that are given in Table 7.

Table 7. *Functional male to female flower ratios*

Clones	No. of inflorescences observed (No. trees)	Ratio
PB 86	50 (1)	12:1
RRIC 100	64 (3)	12:1
RRIC 101	43 (2)	19:1
RRIC 104	98 (2)	10:1

Selection of 1974, 1975 *and* 1978 *hand pollinated (H.P.) seedlings (BST/1/HPS/74 – 75/1) and (BST 1/HPS/74, 75.78/1)*

On the basis of the Morris – Mann test tapping carried out on small scale trials established to evaluate 1974 H. P. selections, four genotypes were selected for large scale testing. But two of these selections 74 – 141 and 74 – 157 were found to be susceptible to *Corynespora* leaf disease and therefore discarded from future testing programme. Both these clones had RRIC 103 as one of their parents. The other two selections, 74 – 193 and 74 – 181 are of the same parentage, RRIC 100 X RRIC 101.

Annual girth measurements were recorded from the 5 small scale trials established to evaluate 1974 H.P. selections.

Trials planted at Moralioya, Yatadola and Dartonfield Estates were opened for tapping during 1986. Trial at Perth State Plantation will be opened for tapping in 1987. Trial at Arapolakanda State Plantation had a poor growth because of the terrain and large outcrops of rocks.

Out of four control clones, RRIC 100, RRIC 121 had recorded the highest mean girth in the three trials planted at Moralioya Estate, Yatadola and Perth State Plantations. Mean girth of the control clones and test clones that exceeded the best control is given in Table 8.

Table 8. *Mean girth in cm of control clones and test clones that exceeded the best control (BST 1/HPS 74–75/1)*

Moralioya		Yatadola		Perth	
Clone No.	Mean girth	Clone No.	Mean girth	Clone No.	Mean girth
74–93	64.4	74–208	57.8	74–147	58.4
74–166	64.1	74–173	56.1	74–144	52.0
74–141	63.7	74–202	55.1	74–141	51.0
74–147	61.4	74–166	55.1	74–156	49.2
74–9	60.2	74–181	54.4	RRIC 121	48.7
74–144	59.4	74–200	53.6	RRIC 103	46.0
74–157	58.8	74–207	53.6	RRIC 100	45.6
74–1	58.1	74–192	52.4	RRIM 600	38.2
RRIC 121	57.4	74–220	52.4		
RRIC 103	52.9	74–213	52.1		
RRIC 100	50.2	74.175	52.1		
RRIM 600	47.5	RRIC 121	51.8		
		RRIC 103	51.7		
		RRIC 100	48.3		
		RRIM 600	45.0		

Small scale trial at Kuruwita sub-station to evaluate seventeen 1974 selections was planted in 1982. Annual girth measurement was recorded in 1986. RRIC 100 had the highest mean girth of 39.9 cm when compared with other three clones, RRIC 121, RRIC 103, RRIM 600 and PB 86. Eleven selections had mean girth measurements exceeding 39.9 cm. Mean girth of these eleven clones and control clones are given in Table 9.

Table 9. *Mean girth of control clones and eleven selections that exceeds the best control clone (BST 1/HPS 64–75/1)*

Kuruwita sub station

Clone No.	Mean girth(cm)
74–140	45.5
74–12	44.3
74–135	43.8
74–180	43.8
74–103	42.4
74–41	42.2
74–199	41.9
74–205	40.6
74–193	40.5
74–162	40.1
74–22	40.1
RRIC 100	39.9
RRIC 121	39.3
RRIC 103	35.4
RRIM 600	33.1
PB 86	33.0

In the three trials established at Clyde State Plantation, Sorana State Plantation and Padukka State Plantation to evaluate some of the selections made from 1975 H.P. seedling populations, RRIC 103 showed the best growth in term of mean girth at Clyde State Plantation whereas at other two sites RRIC 121 showed the highest mean girth. The mean girth of the control clones and the mean girth of the new selections that had higher mean girth values are given in Table 10. (N. E. M. Jayasekera, K. B. Karunasekera, K. W. Rupatunga and B. M. S. G. Peiris)

Table 10. *Mean girth* (1986) *of control clones and new selections with higher mean girth* (*BST/HPS/74–75/1*)

Clyde		Sorana		Padukka	
Clone No.	Mean girth	Clone No.	Mean girth	Clone No.	Mean girth
75–141	39.1	75–104	39.1	75–141	37.2
75–275	38.4	75–79	38.9	75–240	35.7
75–240	37.9	75–71	38.1	75–263	34.9
75–104	37.3	75–4	37.5	75–275	33.8
75–143	36.6	75–36	36.6	75–143	33.4
75–79	36.4	75–81	35.8	RRIC 121	33.0
75–232	36.3	75–117	35.8	RRIC 103	32.2
75–117	35.5	RRIC 121	34.5	RRIC 130	31.6
75–40	35.5	RRIC 130	33.1	RRIC 100	31.5
RRIC 103	35.4	RRIC 103	32.7	RRIM 600	30.5
RRIC 100	33.9	RRIC 100	32a2		
RRIC 121	33.6				
RRIC 130	30.7				
RRIM 600	30.5				

1976 *H. P. Selection* (*BST/HPS/76/2*) *Tempo Division Hill Stream State Plantation* (*S.P.*)

Twenty nine genotype selected from 1976 H.P. seedling progeny are tested in this small scale clone trial planted in 1985. RRIC 100, RRIC 102, RRIC 103 and RRIC 121 have been used as control clones. A diameter measurement was recorded in this experiment. (N. E. M. Jayasekera, I. D. M. J. Sarathkumara and K. W. Rupatunga)

1979 *to* 1981 *H. P. seedling population at Eladuwa State Plantation* (*BST 1/HPS 79/2, BST 1/HPS/80/1 and BST 1/HPS/81/1*)

Seedlings derived from 1979, 1980 and 1981 hand pollination programmes are planted as fully randomized single tree plots in three separate trials. Girth measurements were recorded in all these trials. 1979 seedlings will be opened for normal tapping in 1987 and test tapping too will commence about three months after opening the tapping cuts. Mean girth of the families evaluated and the family size in the 1979 trial are given in Table 11. Family RRIC 100 X 101 showed the highest mean girth followed by RRIC 100 X RRIC 600. (N. E. M. Jayasekera, K. W. Rupatunga and K. B. Karunasekera)

Table 11. *Families, family size and mean girth (BST/HPS/79/2)*

Families	Family size	Mean girth
RRIC 101 x RRIM 600	308	50.9
RRIC 101 x RRIM 623	2	41.0
RRIC 100 x RRIM 600	18	54.5
RRIC 100 x RRIC 101	17	59.7
RRIC 102 x RRIM 600	34	47.1
RRIC 102 x RRIM 623	3	46.1
RRIC 103 x RRIM 600	13	48.1
RRIC 103 x RRIM 623	28	53.9
RRIC 103 x RRIC 101	9	54.1

Clone evaluation in Bibile Group (BST 1/V/67/20 and BST 1V/73/37)

Two clone evaluation trials are in progress at Bibile Group. The mean girth and yield in terms of grams per tree per tapping (g/t/t) of the clones tested are given in Table 12 and Table 13. In BST 1/V 67/20 where six clones are tested IAN 45/710 has recorded the highest average girth followed by RRIC 103 which is highly susceptible to *Corynespora* leaf disease in wet areas. But the disease has not been detected in dry areas such as Moneragala, Bibile, Matale and Kurunegala. Highest yield has also been recorded in RRIC 103. In the other trial RRIC 104 recorded the highest girth but unregistered clone 1461 had registered the highest mean yield. RRIC 117 which yielded highest in 1985 recorded a very poor mean yield of 44.7. Reason for this is the changing over of tapping panel which affected some clones more than the others. (B. M. S. G. Peiris and R. A S. K. Ranatunga)

Table 12. *Mean yield and girth (BST 1/V/67/20) (Tapped s/2, d/2 on panel BI–1)*

Clone	Plots	Trees tapped	Girth cm at 150cm	Yield g/t/t 1985	1986
RRIC 103	2	50	85.5	57.8	58.6
IAN 45/710	3	75	88.1	56.8	56.0
RRIC 100	3	75	76.0	56.9	51.5
RRIC 112	3	75	78.9	42.6	50.0
RRIC 101	3	75	76.0	46.2	48.5
RRIC 45	3	75	80.3	35.1	38.8

Table 13. *Mean yield and girth (BST 1/V/1/73/37) Bibile Group (s/2/d/2 on BO–1 and BO–2)*

Clone	Trees tapped	Dry trees	Girth cm at 150 cm	Yield g/t/t 1985	1986
1461	128	—	69.2	56.0	62.0
RRIC 110	113	1	68.9	61.8	60.9
RRIC 103	167	4	70.4	56.3	59.8
RRIC 102	142	2	65.6	53.2	56.3
RRIC 112	205	1	68.3	58.8	46.0
RRIC 117	54	—	66.7	71.5	44.7
RRIC 104	126	—	74.8	51.4	43.5
506	89	—	59.8	51.6	42.0
RRIC 105	125	1	69.2	48.6	35.3

Evaluation of Ivory Coast clones Paiyagala State Plantation (BST 1/ICC/85/2)

A diameter measurement was recorded in this small scale trial established in 1985 to evaluate 10 clones received from Ivory Coast. RRIC 100, RRIC 102, RRIC 103 and RRIC 121 have been included as control clones in this trial planted as a radomized block design with four replicates. (N. E. M. Jayasekera and I. D. M. J. Sarathkumara)

Clone trial at Kuruwita Sub-Station (BST 1/VSM/67/5, BST 1/VSM/68/21 and BST/1/VSM/69/28)

All these trials are small scale clone trials. Mean girth and yield of the clones in experiment No. BST 1/VSM/67/5 are given in Table 14.

Table 14. *Mean girth and yield (BST 1/VSM/67/5)*

Clone	Trees tapped	Girth cm at 150 cm	Yield g/t/t 1985	1986	Dry trees
RRIC 121	17	104.7	87.0	87.5	5
10727	14	83.5	33.5	62.5	—
RRIM 623	28	75.4	34.9	44.2	3
RRIM 122	5	74.1	33.4	38.9	1
7281	17	85.0	46.2	34.1	—

In this trial RRIC 121 has the highest mean girth and yield. Yields of other clones have gone up in 1986 when compared to 1985, the year in which change over the tapping panel took place. In clone tiral BST 1/VSM/68/21 eleven RRIC 100 series clones and two unregistered clones are tested using RRIC 45 as the control. RRIC 121 recorded a highest mean yield of 136.4g per tree per tapping. This yield is less than what has

been recorded in 1985. With respect to vigour RRIC 133 is the best followed by RRIC 121. All RRIC 100 series clones had better growth and yield than the control clone. Mean yield and girth are presented in Table 15.

Table 15. *Mean girth and yield (BST/VSM/68/21)*
(Tapped s/2, d/2, on panel BI–1)

Clone	Percentage	Trees tapped	Girth cm at 150cm	Yield g/t/t 1985	Yield g/t/t 1986	Dry trees *
RRIC 121	PB 28/59 x IAN 873	6	112.8	178.4	136.4	—
RRIC 133	IAN 710 x RRIC 45	8	116.8	72.3	94.9	3
RRIC 131	PB 86 x F 633	7	84.9	85.5	81.5	1
RRIC 123	IAN 710 x Ch 26	12	93.2	86.9	78.7	4
6–541	RRIC 36 x RRIC 36	7	97.0	73.0	75.3	—
RRIC 102	RRIC 52 x RRIC 7	15	84.2	75.9	68.9	5
RRIC 130	IAN 710 x RRIC 52	13	78.3	78.6	66.8	1
RRIC 113	RRIC 52 x RRIC 36	7	89.1	68.0	61.0	1
RRIC 104	RRIC 52 x Tjir 1	11	106.4	60.0	59.5	5
RRIC 110	LCB 1320 x RRIC 7	11	86.5	82.3	59.2	1
RRIC 120	RRIC 36 x FX 516	18	79.0	51.9	65.9	4
RRIC 112	RRIC 41 x Ch 26	16	80.8	47.8	45.8	—
RRIC 45	RRIC 8 x Tjir 1	17	74.2	37.9	45.3	6

* Dry trees

In the clone trial BST/VSM/69/78 ten clones are evaluated and mean girth and mean yield are given in Table 16. As in 1985 the highest mean girth (102.5) and highest mean yield (102.5g/t/t) were recorded by RRIC 128, (B. M. S. G. Peiris and R. A. S. K. Ranatunga)

Table 16. *Mean girth and mean yield (BST 1/VSM/69/28)*
(Tapped s/2, d/2 on panel BI–1)

Clone	Trees tapped	Girth cm at 150cm	Yield g/t/t 1985	Yield g/t/t 1986	Dry trees
RRIC 126	14	90.2	100.2	102.5	2
RRIC 128	17	90.1	80.1	82.5	1
7–1189	16	72.6	51.8	62.8	4
6–746	13	84.4	62.3	60.4	—
7–1415	15	79.8	52.3	56.8	1
RRIC 127	10	73.7	50.1	54.4	2
RRIC 125	14	67.7	60.9	53.1	—
7–1413	18	80.2	54.1	52.0	1
RRIC 129	10	80.1	44.0	47.0	2
RRIC 124	16	70.2	50.0	45.5	3

Miscellaneous clone trials

International clone trial – Hewagama estate (BST 1/ICT/78/2 and BST 1/ICT/79/3)

This experiment was brought into tapping in 1986 and arrangements have been made to test – tap RRIC clones and imported clones such as BPM 24, PR 305 and RRIM 728 which have given high yields (during 1st three years) in the international clone trials planted in other countries. (N. E. M. Jayasekera, B. M. S. G. Peiris and R. A. S. K. Ranatunga)

Rootstock – scion trial (SC/76/1)

Sixteen rootstock-scion combinations are evaluated in this trial planted at two sites. Mean girth and mean yield for 16 rootstock-scion combinations are given in Table 17. (N. E. M. Jayasekera, K. B. Karunasekera, K. W. Rupatunga and I. D. M. J. Sarathkumara)

Table 17. *Mean girth (cm) and mean yields in g/t/t/ (Tapped at s/2, d/2 on panel BO–1)*

Combination	Site 1		Site 2	
	Girth	Yield	Girth	Yield
RRIC 100 x RRIC 100	52.79	28.3	56.37	29.58
RRIC 100 x RRIC 52	52.51	28.9	58.01	29.15
RRIC 100 x RRIC 111	52.15	34.4	56.08	27.27
RRIC 100 x 1004	51.87	29.4	59.5	29.16
RRIC 52 x RRIC 100	58.52	14.2	64.76	15.26
RRIC 52 x RRIC 52	58.6	19.1	66.74	17.80
RRIC 52 x RRIC 111	60.66	19.7	66.5	16.46
RRIC 52 x 1004	59.58	17.8	69.57	17.69
RRIC 111 x RRIC 100	64.85	21.9	66.93	29.08
RRIC 111 x RRIC 52	62.52	23.2	68.02	24.02
RRIC 111 x RRIC 111	63.83	22.6	65.82	27.10
RRIC 111 x 1004	63.88	22.1	68.79	25.43
1004 x RRIC 100	45.42	15.6	56.37	22.79
1004 x RRIC 52	45.27	17.9	57.3	19.60
1004 x RRIC 111	41.95	16.9	55.1	19.33
1004 x 1004	47.73	16.1	56.8	19.90

Testing of RRIC 100 series clones (BST 1/CET/79/1)

This trial was opened for tapping in late 1986 and test tapping will be carried out in 1987. A girth measurement was recorded and mean girth for clones in this trial is presented in Table 18. The highest growth in terms of girth is reached by RRIC 104. Unfortunately this clone has been found to be susceptible to *Corynespora* leaf disease. (N. E. M. Jayasekera, K. B. Karunasekera, K. W. Rupatunga and I. D. M. J. Sarath Kumara)

Table 18. *Mean girth (BST 1/CET/79/1)*

Clone	Eladuwa	Elston	Peenkanda	Hathbewa
RRIC 100	51.9	60.4	56.1	53.9
RRIC 101	53.3	59.7	52.4	54.5
RRIC 102	58.1	61.5	57.0	58.5
RRIC 103	56.0	65.7	58.8	59.7
RRIC 104	60.2	64.7	60.0	60.8
RRIC 105	56.3	58.9	55.4	54.3
RRIC 107	56.8	67.2	61.5	59.4
RRIC 118	51.7	59.6	56.5	58.8
RRIM 600	49.9	54.4	49.2	51.4
PB 86	44.4	50.5	44.0	50.7
GT 1	48.1	56.0	48.6	48.2
Site mean	53.5	59.8	54.5	55.4

Genotype-environment interaction studies (GE/75/1)

During 1986 tapping panels were changed. The mean yield of clones and number of test tapping in each site are given in Table 19. In terms of g/t/t highest yield was recorded by RRIM 600 followed by RRIC 103.

Mean girth for 1986 is presented in Table 20. Highest mean girth when averaged over all sites was recorded by RRIC 52 followed by RRIC 103.

Table 19. *Mean yield (g/t/t) and number of test tappings (GE/75/1)*

Clone	Hunuwela	Golinda	Bentota	Kanana	Moralioya	Densworth	Bibile	Clone mean
PB 86	24.85	24.29	25.91	27.90	34.47	34.64	25.02	28.15
RRIC 100	22.19	23.51	33.49	33.21	38.87	42.64	29.68	31.94
RRIC 101	28.61	23.54	24.94	34.78	38.88	58.69	30.51	34.29
RRIC 103	37.04	22.70	40.37	47.97	52.46	45.37	31.70	39.65
RRIC 52	20.73	14.24	27.03	25.32	27.06	27.21	20.72	23.18
RRIM 600	41.68	34.36	58.57	40.46	54.82	57.98	29.29	45.30
RRIC 36	19.10	24.34	36.63	22.56	34.77	43.40	30.40	30.17
RRIM 623	19.92	15.46	20.21	34.00	36.42	48.98	29.49	29.21
RRIC 102	32.93	22.54	42.38	36.34	36.68	44.77	30.25	35.12
IAN 45/710	33.62	25.95	46.05	45.63	39.82	42.53	32.46	37.95
Site mean	28.06	23.12	35.55	34.81	39.42	44.62	28.95	33.49
Number of test tapping	9	7	9	6	9	7	7	

Table 20. *Mean girth (GE/75/1)*

Clone	Hunuwela	Golinda	Bentota	Kanana	Moralioya	Densworth	Bibile	Clone mean
PB 86	63.1	67.4	65.0	69.3	63.8	66.9	56.45	64.55
RRIC 100	57.3	58.3	64.7	62.8	62.4	63.07	59.97	61.21
RRIC 101	62.1	56.9	62.3	62.1	63.6	67.3	59.47	61.95
RRIC 103	73.1	63.4	76.3	78.0	74.5	72.2	68.49	72.28
RRIC 52	76.7	69.6	85.0	82.8	78.0	84.2	75.57	78.81
RRIM 600	68.1	66.6	74.8	70.3	68.3	70.1	61.82	68.57
RRIC 36	55.5	59.8	65.1	58.0	63.9	66.4	60.92	61.37
RRIM 623	69.4	65.5	74.2	67.9	68.2	71.4	64.04	68.65
RRIC 102	66.2	56.2	68.0	63.8	63.8	67.7	61.52	63.88
IAN 45/710	69.7	64.5	75.5	76.4	66.6	71.8	66.63	70.15
Site mean	66.12	62.81	71.09	69.14	67.31	70.10	63.48	67.14

REVIEW OF THE PLANT PATHOLOGY DEPARTMENT

By

A. dE S. LIYANAGE

SUMMARY

Corynespora leaf spot disease was detected for the first time in Dartonfield Estate, in the latter period of 1985. At the same time the disease was detected in leaf samples sent from Elpitiya S. P., Sorana S. P., Lavent Estate, Perth S. P., Parambe Estate, Culloden S. P., Miriswatta S. P. and Mirishena S. P. on December 24 1985, January 8 1986, January 20 1986, January 27 1986, February 6 1986, February 19 1986 and May 30th 1986, respectively. Most of the research work was therefore done on this disease in late 1985 and early 1986. A sudden out break of the disease was observed again in September 1986 in several rubber estates and a considerable amount of time was spent on carrying out an island wide survey in nurseries and in mature plantations. Several high yielding clones were found to be susceptible to this disease.

Of the fungicides tested against *Corynespora cassiicola* Benlate, Dithane M 45, Captan, and Antracol were effective in controlling *Corynespora* leaf spot disease.

A survey on the incidence of white root disease in Ratnapura District indicated that there is a considerable reduction in the extent of infection.

In order to evaluate the specific activity of VA mycorrhizae, a phosphorus response curve was obtained for *Pueraria phaseoloides*, under green house conditions.

A preliminary survey carried out on the nitrogen fixing performance of *P. phaseoloides* established under traditional cultural practices showed that despite vigorous growth of the host plant, nodulation and nitrogenase activity were disappointingly low.

P. phaseoloides grown in pots showed a high potential for fixing atmospheric nitrogen compared to its counterparts *Desmodium ovalifolium* and *Mimosa invisa*. All these plants had a more or less similar percentage phosphorus and potassium content while *D. ovalifolium* had a significantly ($P < 0.05$) lower nitrogen content than *Pueraria* and *Mimosa*.

Pueraria, *Desmodium* and *Mimosa* exhibited a diurnal rhythm in nitrogenase activity dependent upon light intensity. *M. invisa* responded to high soil temperature in addition to light intensity.

Staff

The Head of the Department and Deputy Director (Research), Dr A. de S. Liyanage left for U. K. on the 14 January 1986 on sabbatical leave to Imperial College, University of London on a fellowship awarded by the Royal Society of England and returned to the island on the 19 November 1986. He then proceeded to Indonesia on the 23 November 1986 to present an invitational paper at the National Rubber Conference held in Sumatra, Indonesia from 24 November 1986, then proceeded to Java as a consultant to review the research programme in the Plant Pathology Department of the Estate Crops Research Institute in Bogor and to advise the Indonesian Rubber Research Institute on disease control. He returned to Sri Lanka on the 30 December 1986. Mrs N. I. S. Liyanage, Asst. Plant Pathologist left for U. K. on the 14 January 1986 to continue her PhD studies. Mr C. K. Jayasinghe, Asst. Plant Pathologist was appointed as the Acting Head of the Plant Pathology Department from 1 February 1986 to 15 July 1986. Mr C. K. Jayasinghe proceeded to Australia to continue his PhD studies on the 15 July 1986. Dr (Mrs) A. C. I. Samaranayake was then appointed as the Acting Head of the Plant Pathology Department on the 15 August 1986. Mr A. H. R. Jayaratne, Assistant Plant Pathologist, Mr W. Ameratunge Senior Technical Officer Mr S. S. Warnapura, Mr E. A. T. Senadheera, Technical Officers and Mrs Priyani Amarasekera, Clerk/Typist were on duty throughout the year. Mr W. A. D. D. S. Wettasinghe, Senior Technical Officer left for Australia to undergo training on biological nitrogen fixation and returned to RRI on the 29 December 1986 after 9 months training period. Mr B. Fernando, Senior Technical Officer, returned from Brazil on the 24 March, 1986 after undergoing training on South American leaf blight disease. Mrs J. L. P. Wettasinghe, Technical Officer, was away in Australia for 7 months on no pay leave.

Mr Ananda Dharmaratne, Senior Technical Officer resigned from the R. R. I. on the 1 October 1986 to join the JEDB as an Assistant Superintendetnt.

Research students

Mr M. A. P. K. Seneviratne and Mr V. Perera continued their post graduate studies funded by the Rubber Research Institute and the Natural Resources Energy and Science Authority, respectively.

Misses Fiona Ferdinandes and Wasantha Pahalawattaarachchi, from the Ruhuna University successfully completed their projects entitled "A comparative population study of the Endogonaceae" and Evaluation of the significance of VA mycorrhizae on root disease resistance of *Pueraria* respectively, under the supervision of Dr A. de S. Liyanage and Mr A. H. R. Jayaratne.

The following visits were undertaken by the staff of the Department.

Experimental	404
Advisory	38
Miscellaneous	92

Meetings

The Head of the Plant Pathology Department addressed the Superintendents and Asst. Superintendents of SLSPC III, IV, V and JEDB II and IV, on the identification of *Corynespora* leaf disease.

Training

Mr Pham Van Vinh, Rubber Research Institute, Vietnam, underwent a training course in Plant Pathology. He also spent 1 month at the Soils and Plant Nutrition Department at the R.R.I. and returned to Vietnam after one year.

Mr C. K. Jayasinghe, and A. H. R. Jayaratne were involved in training Superintendents, Asst. Superintendents, on aspects of disease control. Training was also provided for Rubber Extension Officers.

Publications

Dharmatilake, A. J., Wijesundera, R. L. C. and Liyanage, A. de S. (1986). A study of the cell-wall degrading enzymes secreted by isolates of *R. lignosus*, the causative agent of white root disease of rubber. *Paper presented at the Sri Lanka Association for Advancement of Science.*

Liyanage, A. de S. (1986). Strategies to control *Hevea* leaf diseases. *International paper presented at the Natural Rubber Conference Indonesia*, 24–28 November.

Samaradeewa, P. K. and Liyanage, A. de S. (1986). Reactions of resistant and susceptible *Hevea* clones to *Colletotrichum gloeosporioides. J. Nat. Rubb. Res.* 1 (3) 187 – 194.

ජයසිංහ, සී. කේ., (1983). රබර් වගාවේ පලිබෝධකයෝ: ගොළුබෙල්ලන් සහ හමිබෙල්ලන්. රබර් පුවත් 11, 1-2.

Reports

Liyanage, A. de S. (1985) Annual Review of the Plant Pathology Department.

General

Corynespora leaf spot disease which was first detected in a polybag nursery in Dartonfield Estate and other estates in December 1985 and early 1986 reached epidemic proportions in the latter part of 1986, in several rubber growing districts of Sri Lanka. This disease appears to be a potential threat to some of the high yielding new clones particularly RRIC 103 and 104. Most of the research work was concentrated on *Corynespora* leaf spot disease. An island wide survey on *Corynespora* leaf spot disease was therefore, conducted.

Incidence of *Oidium* leaf disease was mild in most areas but at high elevations the disease was severe particularly in some estates in Ratnapura District.

The damage caused by *Phytophthora* species was mild in most estates.

Laboratory Investigations

Diseased specimens

The following specimens were sent to the Institute, for identification.

Pest damage	4
Fungal diseases	22

Biology

Corynespora cassiicola (C/85/1)

Effect of temperature at 50% *and* 100% *relative humidity* (*RH*)

An experiment was conducted to find out the effect of temperature and humidity on the germination of spores of *Corynespora cassiicola*. It was observed that at 100% humidity 96% of the spores germinated even at 35°C. However, at 50% humidity spore germination was low at all temperatures. The results are given in Tables 1 and 2. (A. de S. Liyanage, A. H. R. Jayaratne and S. S. Warnapura)

Table 1. *Effect of temperature on spore germination of* C. cassiicola *at* 100% *RH*

Temperature(C°)	15	20	25	(RT)	30	35	40
Germination (%)	5	87	99	98	96	96	2

RT = 28± 2C°

Table 2. *Effect of temperature on spore germination of* C. cassiicola *at* 50% *RH*

Temperature (C°)	20	25	(RT)	30	35	40
Germination (%)	6	3	2	2	Nil	Nil

RT = 28 ± 2°C

Epidemiology

Corynespora cassiicola (C/85/1)

Effect of sunlight on survival of spores

It was observed that, 98% of the spores remained viable even after the infected leaves were exposed to 6 h of direct sunlight. 6% of the detached spores (on glass slides) remained viable when they were exposed to 2h of direct sunlight. However, detached spores on leaf discs showed 32% germination after 4 h of exposure to direct sunlight. 67% of the detached spores (on glass slides) remained viable when they were exposed to 6 h of diffused sunlight (on the laboratory bench). However, detached spores on leaf discs showed 80% germination after 6 h of exposure to diffused sunlight on the laboratory bench. (A. de S. Liyanage, A. H. R. Jayaratne)

Survival of spores on leaf litter

Necrotic lesions on infected leaves were observed to produce about 1,200 spores/cm^2. Spores on infected leaves were able to survive under field conditions upto 30 days during which period 90% of the spores remain viable. (A. de S. Liyanage and A. H. R. Jayaratne)

Phytophthora meadii

Nomenclature (*P*/76/1)

The *Phytophthora* isolates collected from different countries where rubber is grown, were separated into 5 species mainly on the basis of important morphological characters. Of the several criteria examined pedicel length proved to be the most useful.

Of the Sri Lankan isolates of *Phytophthora*, one isolate collected in December 1985 from Dartonfield Estate, outside the normal disease period, was identified as *P. citricola* Sawada. This is the first record of this pathogen on rubber in any rubber growing country in the world.

Pathogenicity (*P*/76/1)

The results of pathogoenicity experiments showed that isolates of *P. palmivora* from cocoa could infect petioles of currently grown clones of rubber. Similarly, the ability of several species of *Phytophthora* from rubber to cause infection of cocoa pods of the widely grown variety Amelonado was also demonstrated. This shows that it is possible for cross infection to occur when rubber and cocoa are interplanted. However, inter specific pairings of *P. meadii* isolates from rubber and *P. palmivora* isolates from cocoa produced 23 – 33% abnormal oogonia. Even though nearly one-third of the oogonia were abnormal, the presence of a large number of normal oogonia indicate the high risk of interplanting cocoa with rubber especially in wet areas. However, in dry areas where conditions are unfavourable for disease development, intercropping could be attempted. (N. I. S. Liyanage)

Propagule production (*P*/76/1)

Incubation of paired cultures of *Phytophthora meadii* in the dark at temperatures between 18° and 22° C proved most favourable for the formation of oogonia and antheridia. Oogonia formed abundantly in the dark, with light-apparently inhibiting oogonia production. Similarly, chlamydospores formed most abundantly in the dark and at temperatures below 20°C. It might be assumed that temperature generally in the rubber growing areas of Sri Lanka are too high to favour either the production of oogonia or chlamydospores. However, although the daytime temperatures are usually between 25° and 28° C, at night they fall to 20° – 22°C especially at altitudes of 100 – 300 m. In this range atleast oogonia could be formed.

Both mycelia and sporangia are not long term survival propagules of *Phytophthora meadii*. The fungus could be recovered from mycelium incubated in soil only for 3-4 weeks. Sporangia too are rapidly decayed in soil and most sporangia are degenerated in a short time of three days. The mycelium within the host tissue could remain viable for longer periods upto 6 weeks. The fungus also remains in infected petioles as thin-walled chlamydospores. Later, they become thick-walled and remain in the petiole tissue till it is fully decayed. It is most likely that these thick-walled chlamydospores are the means by which *P. meadii* perennates in soil. (N. I. S. Liyanage)

Phytophthora palmivora (*IC*/84/1)

So far seventy isolates have been collected from cacao pods affected by *P. palmivora* in Kalutara, Kandy and Matale Districts. This study was initiated to examine the species of *Phytophthora* that affect cacao, prior to it being tested on a large scale as an intercrop in rubber, in the wet low country districts. (A. de S. Liyanage and M. A. P. K. Seneviratne)

Field Investigations

Disease Incidence

Corynespora cassiicola (*C*/85/1).

An island-wide survey was conducted on disease incidence in September 1986. The observations are summarised in Table 3. (A. de S. Liyanage, A. H. R. Jayaratne, S. S. Warnapura, E. A. T. Senadheera and E. B. Fernando)

Table 3. *Incidence of* Corynespora *leaf disease*

Regions	No. of estates surveyed	Incidence of *Corynespora* leaf spot disease			
		Polybag	Budwood	Seedling	Replanting
Kalutara	31	5	17	35	15
Kegalle	25	Nil	Nil	Nil	Nil
Kelani Valley	38	1	4	3	6
Ratnapura	30	4	12	13	2
Galle	33	2	5	5	2
Matale	5	Nil	Nil	Nil	Nil
Moneragala	3	Nil	Nil	Nil	Nil

Rigidoporus lignosus (*F*/76/5)

A survey was conducted to re-assess the incidence of white root disease in four estates of Ratnapura District, Table 4. (A. de S. Liyanage, E. A. T. Senadheera)

Table 4. *Extent infected with white root disease in different estates*

Estate	Infected hecterage (%)
Peenkanda	2.93
Keeragala	0.75
Palmgarden	1.31
Rilhena	0.55

This survey indicated a considerable decline in the extent of infection, compared to the level of infection recorded in these estates in 1978.

Clonal susceptibility

Corynespora cassiicola (C/85/1)

Fourteen clones viz. RRIC 52, RRIC 103, RRIC 104, RRIC 106, RRIC 107, RRIC 118, NAB 12, Tjir 1, IAN 873, RRIM 725, FX 25, PPN 2444, PPN 2447 and KRS 21 were found to be severely susceptible for *Corynespora* leaf spot disease. (A. de S. Liyanage, S. S. Warnapura)

Control

Corynespora cassiicola (C/85/1)

Several fungicides were tested against *C. cassiicola* both *in vivo* and *in vitro* and found that Benlate (0.3%), Dithane M 45 (0.3%), Captan (0.4%) and Antracol (0.4%) were effective in controlling the disease. (A. de S. Liyanage, C. K. Jayasinghe, S. S. Warnapura and Pham Van Vinh)

Rigidoporus lignosus (F/76/7)

'Calixin' collar protectant was used in controlling white root disease in comparison with the recommended collar protectant. The results are being analysed. (A. de S. Liyanage and S. S. Warnapura)

Phytophthora species (P/84/1)

A new fungicide 'Sandoz' was tested in the field against bark rot caused by *Phytophthora* species. This fungicide proved to be a promising fungicide both on immature nursery plants and mature rubber trees in controlling *Phytophthora* panel disease. Both preventive and curative action of the fungicide were noteworthy. (N. I. S. Liyanage, S. S. Warnapura and E. B. Fernando)

Nitrogen Fixation

Studies on nitrogen fixation of leguminous cover crops (Nfxn/84/1)

A survey was conducted in the rubber estates of Sri Lanka to observe the growth and nitrogen fixing abilities of established legumes under traditional cultural practices. The results are summarised in Table 5.

Table 5. *Dry matter production, nodulation and acetylene reduction by* P. phaseoloides *established under experimental and traditional cultural practices*

Locality	Dry matter yield (kg/ha)	±SE	Nodule dry weight(kg/ha)	±SE	AR activity (m moles/ha/h)	±SE
Experimental site	3422.0	± 348.0	77.32	± 9.26	1480.70	± 159.64
Newchatel S.P.	3755.0	± 286.3	16.02	± 2.98	71.45	± 12.79
Dartonfield S.P.	3371.0	± 267.8	29.15	± 3.27	177.30	± 22.11
Padukka S.P.	3853.3	± 332.7	25.40	± 5.96	222.95	± 47.79

From these observations it could be concluded that although dry matter production was satisfactory the nodulation and nitrogen fixation ability of traditionally established *P. phaseoloides* were extremely poor. Therefore, it seems that *P. phaseoloides* grows mainly at the expense of soil nitrogen eventhough they are maintained with the primary purpose of fixing atmospheric nitrogen.

A series of pot experiments were conducted to determine the diurnal fluctuations in nitrogenase activity of leguminous cover crops. All experiment plants viz. *P. phaseoloides, D. ovalifolium* and *M. invisa* showed a diurnal rhythm with light intensity. The lowest nitrogenase activities were determined around midnight and they were actively fixing nitrogen by 8.00 a.m. However, it is interesting to note, that *M. invisa* responded to high soil temperature in addition to light intensity. A marked drop in acetylene reduction activity was detected around 4.00 p.m. where the soil temperature was around 38°C. (C. K. Jayasinghe and S. S. Warnapura)

Mycorrhizae

Investigations on VA mycorrhizae (MY/85/1)

Effect of VA mycorrhizae on root disease incidence (*MY*/85/1)

A pot experiment was carried out to, evaluate the role of VA mycorrhizae and white root disease incidence on *Hevea* and on *Pueraria* plants.

The plants were grown in sterilised soil: sand (1 :1) mixture and the inoculations were done at three different times.

(a) Both inocula (mycorrhizal and *Rigidoporus*) together.

(b) Mycorrhizal inoculation, when plants have grown for about 50 days.

(c) Inoculation with *R. lignosus*, when plants have grown for about 50 days.

In *Pueraria* plants the development of infection in roots due to both inocula were assessed after 25, 30, 35, 40, 45, 60 and 150 days (Tables 6 & 7).

Table 6. *Mean percentage infection of* Rigidoporus lignosus

Treatment	After 60 days	After 150 days
M_0RP_1	28.0	30.1
M_0RP_2	33.8	31.3
$M^aR^bP_1$	15.0	26.8
$M^aR^bP_2$	9.0	39.3
$M^bR^aP_1$	26.3	29.2
$M^bR^aP_2$	5.8	29.3
MRP_1	8.8	31.7
MRP_2	9.3	41.3
LSD (5%)	12.20	N. S.

Table 7. *Mean VA mycorrhizal percentage infection*

Treatment	After 60 days	After 150 days
MR_0P_1	64.0	70.7
MR_0P_2	59.3	61.7
$M^aR^bP_1$	62.0	64.3
$M^aR^bP_2$	59.5	61.5
$M^bR^aP_1$	57.0	42.0
$M^bR^aP_2$	22.0	40.0
MRP_1	58.0	65.5
MRP_2	51.3	59.3
LSD (5%)	10.93	LSD 9.87

Development of *Rigidoporus* infection is quite slow (Table 6) when compared with that of VA mycorrhizae (Table 7). There is a significant decrease in *Rigidoporus* infection development in mycorrhizal plants up to 60 days (Tables 6 & 7). But after 150 days, the development of *Rigidoporus* infection is not affected by the presence or absence of mycorrhizae.

The results shown in Table 8 indicate that presence of VA mycorrhizae in feeder roots inhibits the development of white root disease infection even after 240 days from inoculation.

Table 8. *Mean percentage* Rigidoporus *infection in seedlings after* 240 *days*

Treatment	In tap roots	In feeder roots
M_0RP_1	71.4	7.4
M_0RP_2	54.6	13.3
$M^aR^bP_1$	Nil	Nil
$M^aR^bP_2$	Nil	Nil
$M^bR^aP_1$	51.7	14.0
$M^bR^aP_2$	68.6	16.6
MRP_1	50.8	16.3
MRP_2	69.2	11.6
LSD (5%)	10.48	5.92

Mycorrhizal infection was significantly less at high level of phosphorus (P_2) in all the treatments (Table 9). The effect of *Rigidoporus* infection on development of mycorrhizal infection is not significant. (A. H. R. Jayaratne, A. de S. Liyanage, Fiona Ferdinandes and Wasantha Pahalawattaarachchi)

Table 9. *Percentage VA mycorrhizal infection after 240 days*

Treatment	Mean % Mycorrhizal infection
MR_0P_1	74.3
MR_0P_2	47.0
$M^aR^bP_1$	46.3
$M^aR^bP_2$	20.0
$M^bR^aP_1$	45.3
$M^bR^aP_2$	14.3
MRP_1	45.3
MRP_2	30.3

M	—	Mycorrhizal inoculum (*Gigaspora margarita*)
R	—	Rigidoporus inoculum
0	—	Without inoculum
a	—	Inoculum introduced first
b	—	Inoculum introduced later
P_1	—	Without added phosphorus
P_2	—	With added phosphorus at the rate of 600 µg/g of soil

Miscellaneous

Litter fall (VP/85/1)

The litter fall in 5 sites have been measured for dry weight and nutrient analysis for a period of 1½ years. The seasonal pattern of canopy litter fall in the rubber sites have been studied and compared with the forest site. The pinus litter fall was also compared with the forest site. In all sites the ground vegetation component has been calculated as a % of the canopy litter. Nutrient variation has been recorded in the monthly litter for a period of one year. Statistical analysis is being carried out to calculate the total nutrient input from litter to soil in all sites. (V. Perera, N. Gunathilaka, A. de S. Liyanage and R. Munasinghe)

Growth & biomass (VP/85/3)

Girth measurements have been obtained every 6 months for a 2 year period in all 5 sites. The live vegetation of the monocrop is being analysed for nutrients. In a rubber site the biomass of a sample of trees have been studied and their growth characteristics have been related to the biomass.

The live ground vegetation has been analysed for nutrients in all sites and their growth monitored, so that the annual distribution of nutrients can be studied, (V. Perera, N. Gunathilaka, A. de S. Liyanage and R. Munasinghe)

Throughfall water analysis (VP/85/5)

The nutrient analysis of throughfall water falling through the canopy of the 5 sites were compared during different times of the year with different intensities of rainfall. The throughfall readings were obtained at different times of the year when the canopy nutrient status was different. Litter decomposition and soil respiration studies were also conducted. (V. Perera, N. Gunathilaka, A. de S. Liyanage and R. Munasinghe)

REVIEW OF THE SOILS & PLANT NUTRITION DEPARTMENT

By

N. YOGARATNAM

SUMMARY

Studies on the mineral nutrition of *Hevea* and associated ground covers and soil-plant-water relations have been the main concern of the Department.

It has been shown that photosynthetically fixed CO_2 moves as sucrose into the C pool of latex in rubber trees and that latex production takes place mainly in the laticiferous cells.

Responses to fertilizer application have been obtained in both immature and mature rubber and in mature rubber mainly for application of N and K containing fertilizers.

In the smallholder sector where fertilizers may not have been applied regularly, it may be possible to obtain yield increases in the region of 22% with application of conventional standard fertilizer mixtures and about 40% with fertilizer application on the basis of soil and leaf analyasis.

Soil and foliar survey programme continued to be popular in providing fertilizer recommendations to mature rubber in the estate sector. Nine thousand hectares were surveyed this year. Anticipated savings on fertilizer bill would be approximately rupees 8.6 million in the estate sector.

Staff

The Head of the Department Dr N. Yogaratnam and the Assistant Soils Chemist D. M. A. P. Dissanayake were on duty throughout the year. Dr M. K. S. A. Samaraweera and Mrs Lalani Samarappuli continued their studies under an IAEA training programme in the Department of Botany Western Australia and University of California, Davis, USA respectively. Mr Manitha Weerasuriya, Temporary Research Assistant continued his studies for the M Phil degree of the University of Peradeniya under the supervision of N. Yogaratnam.

The experimental officers Messrs W. C. Dayaratne, A. M. A. Perera, F. P. W. Silva and H. D. S. P. Perera and the Technical Officers Messrs J. G. de Mel, C. K. Maheepala, S. N. Silva, Manel Mahanama, P. Karunadasa, U. Mitrasena, Anusha Jayaweera and A. N. Yakandawela and Specification Officer Ahamadeen were on duty.

Messrs Ranjani Munasinghe and B. A. Nandalal joined as Technical Officers and Miss Lakshmi Rupasinghe as Stenographer.

Research students

Research students of the faculty of Agriculture, University of Peradeniya and Ruhuna worked on the following research projects in partial fullfilment of the requirement of the specialization course in soil science, under the supervision of N. Yogaratnam.

1. W. A. R. N. Fernando — Studies on some aspects of sulphur nutrition in *Hevea* plantations
2. S. M. M. Iqbal — The effect of Aluminium on the uptake of phosphorus by *Pueraria phaseoloides*
3. K. G. G. Wijesinghe — Effect of herbicides on soil characteristics and weed control under *Hevea*.
4. Asoka Galabada — Factors influencing the Mg content in *Hevea* leaves.

Visits

The Departmental staff paid advisory visits to plantations and routing visits to experimental areas where necessary.

Meetings

The research staff participated in the following meetings.

Seminars

JEDB Avissawella region planters meeting, Avissawella
SLSPC Galle region planters meeting, Galle

Training programmes

Rubber Extension and Advisory Services Dept.
Planter training programme organised by the National Institute of Plantation Management.

Working groups and Committees

N. Yogaratnam served on the following :

Co–ordinating Committee on fertilizer supplies of the Ministry of Plan Implementation.

Technical Committee of the Tender Board of the Ceylon Fertilizer Corporation

Technical Committee of the Sri Lanka Standards Institution

Agriculture group of the Atomic Energy Authority

Working group on the experimental cultivation of Tea and Rubber in Mahaweli area

Technical Evaluation Committee of the analytical laboratories of the Sri Lanka State Plantation Corporation.

Co–ordinating committee of the Sri Lanka Agricultural Research Programme funded by the World Bank.

Scientific Committee of the Rubber Research Institute.

Publications

Yogaratnam, N. and de Mel J. G. (1986). Effect of fertilizers on the leaf composition of NPK in some *Hevea* cultivars (in press)

Yogaratnam, N. (1986). Urea as a source of nitrogen in the nutrition of some *Hevea* cultivars. Paper accepted for presentation at the *International Symposium on Urea Technology, Kuala Lumpur* 1987.

General

Labortory Investigations

Techniques

A short term crop cowpea (Vigna unguiculata (L.) Walp) was used to study new methods connected with the studies on translocation and metabolism of assimilates and nutrients in plants.

Carbon and mineral nutrition of the rubber tree

Seedlings were raised from rubber seeds to study several aspects of carbon and mineral nutrition, physiology and biochemistry of the rubber tree were examined.

The arrangements of conducting tissues in different plant parts were studied, emphasis was on the organisation of the bark. Since the laticiferous vessels are mostly outside the conducting zone, it appears that the radial transport via phloem rays is a possible means of supplying these laticifers with assimilates.

Composition of sugars, organic acids, nitrogenous solutes, mineral elements in different plant parts such as xylem exudates, serum and lutoid particles of latex were determined. Sucrose is the only sugar found in latex. K and malate are equally distributed in the cytoplasm and the lutoid particles. Concentrations of Calcium, Magnesium, Phosphate, Citrate and basic amino acids in the lutoids are several times higher than in the cytoplasm whereas sucrose and acidic amino acids are largely retained in the cytoplasm.

The concentrations of total soluble nitrogen in lutoid and cytoplasmic serum of latex and in xylem sap were of the same order. While almost all the water soluble N in latex was as amino compounds, about 20–40% of the N on the xylem sap was as amino compounds. About 50% of the amino nitrogen in the xylem sap and cytoplasmic serum of latex was in the form of the amide GLN. Higher concentrations of basic amino acids (LYS and ARG) were found in lutoid particles than in the cytoplasmic serum. The concentrations of acidic acids (ASP and GLU) in the lutoid particles were always lower than in the cytoplasmic serum.

The uptake of amino acids by the lutoid particles was studied using ^{14}C — labelled compounds and the increasing order of uptake was as follows: acidic, neutral, asitic and basic. Because of this detailed studies of kinetics of lysine uptake were made. The uptake of amino acids as well as calcium and magnesium against a concentration gradient is an energy consuming process and based on our findings a new hypothesis for the translocation across the lutoid tonoplast was also proposed.

Methods of purification and assaying of enzyme systems were learnt. Invertase was selected as an example because it has an important role in the conversion of sucrose during synthesis of rubber.

Small capillary manometers were constructed to measure the turgor pressure in laticifers.

The fate of photosynthetically fixed carbon in the rubber trees was studied by feeding a few selected leaves with $^{14}CO_2$. Rapid translocation of photosynthetically derived products to all parts of the tree trunk was observed. However in all the trees used, the amount of a radioactivity in the latex obtained from the side of the fed leaf, was always higher than the opposite side. As expected, during the first 24 hours after feeding the highest translocation was in the dark period. Higher amounts of ^{14}C labelled products were incorporated into rubber on the seventh day than on the second day after the feeding. This occurs with a simultaneous decrease in the proportion of radioactivity in the cytoplasmic serum. There is no apparent change with time in the amount ^{14}C in the lutoid particles. The amounts of ^{14}C labelled anionic and cationic compounds formed were too small to be detected. However the ^{14}C in the neutral fractions obtained from lutioid particles and cytoplasmic serum was entirely in the form of sucrose.

These studies confirm that photosynthetically fixed CO_2 moves as sucrose into the C pool of latex in the rubber tree and that the latex production predominantly takes places in the laticiferous cells.

A scientific report giving technical details of the work done was prepared and few research papers have been also prepared for publication and they are now in the manuscript form. (M. K. S. A. Samaraweera, C. A. Atkins in collaboration with J. S. Pate FRS and J. Kuo)

Nutrient deficiencies in sand culture

Study on nutrient deficiency symptoms done in 1980 was repeated to obtain more information. Rubber seeds from different clones were germinated in specially prepared nutrient free sand. Seedling of equal heights from this were transplanted in pots containing nutrient free sand in a green-house. Plants are being treated with specially prepared Hewitt's solution. There are eight treatments replicated five times making in all 40 plots. The nutrients tested include N, P, K, Ca, Mg and S. Girth and height measurements were recorded regularly and leaves were collected at different stages of deficiencies and analysed for their chemical composition. The effect of nutrient deficiency on the following factors which play a vital role on growth, developement and productivity of the rubber tree are being studied in detail.

1. Assimilation and metabolism of mineral nutrients. This is done by studying the composition of xylem exudates, serum and lutoid particles of latex;

2. Nutritional composition and photosynthetic activity of leaves.

3. Relative activities of key enzyme systems involved

4. Partitioning of assimilates within the tree. (M. K. S. A. Samaraweera, H. D. S. P. Perera, C. K. Maheepala)

Field Experiments

Response to fertilizers

Response to K

In Experiment F/76/5 in progress at Eladuwa State Plantation, Matugama the effects of 3 levels of K and 3 tapping systems on the performance of clones PB 86, RRIC 100 and 101 is being studied. Girth and yield data obtained in 1986 indicates that all RRIC 100 series clones grow more vigorously then PB 86 and as a result yield obtained in plots where RRIC 100 series clones are growing is higher than that in the PB 86 area. (N. Yogaratnam, M. Weerasuriya and J. G. de Mel)

Response to NK

Effects of 3 levels of N and K on growth and yield were compared in clones PB 86, RRIC 100, RRIC 101 and 102 in experiment F/76/4. Yield data obtained in 1987 (Table 1) indicates a significant increase in yield to application of nitrogen and partioning

of treatment effects shows the response to be significantly linear. With regard to potassium, application of K at level 1 gave significant ($P < 0.001$) increase of 9% over control and a further increase to level 2 give 15% yield increase over no fertilizer control. (N. Yogaratnam and J. C. de Mel)

Table 1. *Effect of N and K on yield*

Treatments	Yield (Kg/ha)	% increase
N_0	1852	100
N_1	1925	104
N_2	1986*	107*
LSD	92.37	4.9
K_0	1779	100
K_1	1936***	109***
K_2	2046***	115***
LSD	92.37	4.9

K/Mg nutrition

Ten field experiments were in progress studying several aspects of K and Mg nutrition of immature *Hevea*.

Leaf nutrient concentration and girth data of experiments 1 to 7, leaf and latex nutrient concentration, girth and yield data of experiments 8 and 9 and diameter measurements, soil and leaf nutrient concentrations of experiment 10 were collected.

Pot experiments 1 and 2 were uprooted in September and November 1986 respectively. Leaf and soil sampling to assess their nutrient concentrations, diameter and height measurements, a count of number of whorls, bark thickness and micro tapping were done before uprooting the plants. Fresh and dry weights of separated plant parts such as leaves, petioles, stems and roots were assessed and bark analysis was also done for their nutrient concentrations.

Significant increases in leaf potassium content due to the application of potassium at first level (normally recommended level) in experiment 7, 8 and 10 were observed. But further application at level 2 did not have any effort on the K content of leaves.

In experiment 10, a significant reduction in leaf magnesium content due to the application of potassium and a significant increase in leaf magnesium content due to the application of magnesium were observed.

In August 1986 leaf potassium and magnesium concentrations showed a significant interaction between applied potassium and magnesium levels. This interaction was not observed in the previous samples.

The leaf concentration ratios of K/Mg, K/Ca and K/(Ca + Mg) also showed highly significant increases due to application of potassium at both levels. But further increases from the first to the second level did not show any significant effect in K/Mg ratio in August 1985 and March 1986. In August 1986 significant interaction between the applied potassium and magnesium was seen in the K/Mg ratio of the leaves.

In experiments 8 and 10 significant increases in girthing due to the application of potassium were observed. A further increase in applied potassium did not show any change in effect.

In experiment 10 a significant interatction in girth was observed between the applied levels of magnesium and the sources of magnesium viz. kieserite, Dolomite and epsom salt. (S. M. Weerasuriya, N. Yogaratnam and U. Mitrasena)

In experiment, F/84/1, the effects of a few pre and post treatment practices on the performance of immature are being studied on six sites with 8 blocks in a split plot confounded design. The main plot treatments are :

T_1 — Control without organic matter and fertilizer, prior to planting
T_2 — K and Mg before planting
T_3 — Rice straw twice a year
T_4 — Coir dust twice a year

Four levels of K and Mg were applied in the sub-plots. Girth measurements made 24 months after planting indicate a significant ($P < 0.05$) increase in girth to application of K at 270g muriate of potash/plant/year and no further effect was recorded to increase in K level to 400g/year. There are indications that the organic matter (coir dust and rice straw) has a positive effect on the growth of the trees. Samples of soil and leaves are being collected and their nutrient contents and other important parameters are being assayed. (M. K. S. A. Samaraweera, W. C. Dayaratne and S. N. Silva)

Response to NPKMg

Girth data recorded at the end of 11 years after the commencement of fertilizer treatments indicates significant ($P < 0.001$) increase in girthing with application of nitrogen at level 1 and a further increase when nitrogen was increased to level 2 (Table 2).

Table 2. *Effect of nitrogen on girthing of RRIC* 45

Levels of N	Girth (cm)	% increase over control
N_0	63.53	100
N_1	66.56	105
N_2	67.94	107
LSD	1.59	3

Yield was increased significantly ($P < 0.01$) by 13% at level 1 of nitrogen and further increase by 7% was recorded when nitrogen was increased to level 2 (Table 3). As these increases are consistant and have been recorded in the past few years, it appears that mature *Hevea* may require continuous application of nitrogen at rates higher than the currently recommended rates. (N. Yogaratnam and A. M. A. Pererea)

Table 3. *Effect of nitrogen on yield–RRIC* 45

Nitrogen	Yield (kg/ha)	% increase
N_0	1681	100
N_1	1905	113
N_2	2021	120
LSD	162	10

Response to NPKMg in smallholdings (*F*/84/1)

Use of fertilizers in smallholdings is investigated in an experiment on Godigamuwa Estate in Kalutara using clone PB 86 from a 1976 replanting. Fertilizer treatments consists of no fertilizer control, standard fertilizer mixture and fertilizer on the basis of soil and leaf analysis. Yield (Table 4) data obtained in the second year of the experiment shows significant ($P < 0.001$) yield increases to application of conventional fertilizer mixture and an increase of 40% with fertilizers on the basis of soil and leaf analysis. As similar results were obtained in 1986 also, it appears that significant yield increases could be obtained in all small holdings with a history of irregular application of fertilizer during the mature period. (N. Yogaratnam and F. P. W. Silva)

Table 4. *Effect of fertilizers on yield – PB* 86

Treatment	Yield (kg/ha)	% increase over control
No fertilizer control	1064	100
Conventional fertilizer mixture	1301***	122***
Soil & foliar analysis	1475***	140***
LSD	86.3	8

Response to NPK Mg in seedling nursery

Two experiments were started in a seedling nursery at Nivithigalakele in September, 1985 to study the effects of NPKMg on growth and mineral composition of *Hevea* seedlings to be used for green budding.

In both experiments 3^4 factorial confounded design was used to apply 81 treatment combinations with all possible combinations of N, P, K and Mg at three levels (0, 1 and 2). Urea, Rock phosphate, Muriate of potash and kieserite were used in the 1st experiment and Ammonium sulphate was used instead of urea as the source of nitrogen in the 2nd experiment.

Girth measurements made at the end of 6 months showed a positive linear effect to applied N in experiment 1 which explained 75% of the total variation in the diameter, and applied N and Mg accounted for 97% of the total variation in diameter, in experiment 2.

In experiment 2, both N and K significantly experiment contributed to 78% of the variation in weight at the age of 6 months. There were positive linear responses in leaf nitrogen to applied N in both experiments. These linear effects contributed to almost all the variation in leaf N contents. (D. M. A. P. Dissanayake and U. Mithrasena)

Phosphate – Aluminium interaction

In this study the effect of three levels of aluminium applied as aluminium sulphate ($Al_2 (SO_4)_3\ 16H_2O$) and phosphorus as ammonium dihydrogen orthophosphate ($NH_4H_2PO_4$) on growth and mineral composition of *Pueraria phaseoloides* were studied in pots.

Application of aluminium increased the root potassium content and decreased the soil pH.

Phosphate application increased the fresh weight and dry weight of plants also the phosphorus and nitrogen content of the plants but decreased the root magnesium content.

There has been a significant interaction between Al and P on available soil phosphorus. The soil available phosphorus increased with the increase in the levels of applied Al with the range of nutrients levels tested in this study.

It is therefore concluded that increasing the levels of aluminium in soil is not likely to influence the nutritional status of *Pueraria phaseoloides* in particular the phosphate nutrition of the plant during a period of three months. This experiment will have to be continued for sufficiently longer period to obtain some meaningful and conclusive results as visual symptoms to the effect that higher levels Al has a depressive effect on growth and phosphorus content of the plants are seen. It is also interesting to note that higher levels of Al has decreased pH and Al–P interaction has increased the phosphate content in the soil. (N. Yogaratnam, S. M. M. Iqbal and A. M. A. Perera)

Sulphur nutrition

The effect of sulphur containing fertilizers on the performance of *Pueraria phaseoloides* was studied in pots. The treatments tested were (1) ammonium sulphate (2) Kieserite ($MgSO_4$ H_2O) (3) Commercial epsom salt (Mg SO_4. $7H_2O$) (4) Urea (no sulphur control) and (5) No fertilizer control.

In the pot experiment with *Pueraria*, although the S content of the soil that received elemental S was higher than that received in the form of ammonium sulphate, yet application of ammonium sulphate had a greater effect in increasing the S content of leaves than when elemental S was applied. There also appears to be a positive effect of application of S on the P content of *Pueraria* leaves. Application of elemental S has also lowered the soil pH and the average dry weight of the plants.

The N content was higher in the soil that received urea than that received ammonium sulphate, but the leaf N contents were higher with ammonium sulphate than with urea suggesting that a quicker uptake of nitrogen within a short period is possible with ammonium sulphate in comparison with urea in particular on *Pueraria*.

Mg containing fertilizer decreased the K content in *Pueraria* leaves confirming the known relationship between these 2 nutrients. Among the sources of Mg tested, commercial epsom salt appears to be more efficient than kieserite in increasing the Mg content of soil and leaf. Mg deficiency symptoms were also observed in plants that received only ammonium sulphate possibly due to antagonism between NH_4^+ and Mg^{2+} ions.

Higher shoot/root ratios were observed in plants that received N fertilizers in comparison with application of elemental S. In the field study, analysis of leaves suggests that ammonium sulphate is more efficient than urea in increasing the N content of *Hevea* leaves. (N. Yogaratnam, W. A. R. N. Fernando and A. M. A. Perera)

Micronutrients

The effects of two levels of B, Al, Mn and Fe under two soil management practices viz. with and without legume cover on the performance of clones PB 86 and RRIC 103 is being studied in pots at Dartonfield estate. The treatments were allocated in fully randomized design with 2 replicates. The treatments tested are; soil management practices, with and without *Pueraria phaseoloides* as ground cover.

Clones	—	PB 86 and RRIC 105
Micro nutrients	—	Mn, Fe, B and Al at 2 levels.

Results obtained so far do not indicate any treatment effects. (D. M. A. P. Dissanayake, A. M. A. Perera and B. A. Nandalal)

Foliar nutrition

Two experiments were started at Dartonfield to study the effects of foliar nutrient sprays on the performance of *Hevea* planted in polybags. The following 10 nutrient treatments are being tested on clones RRIC 100 and RRIC 121 :

T_1 — Nil
T_2 — NPK (Soil) + Mg (soil)
T_3 — NPK (Soil) + Mg (Foliar)
T_4 — Nutraphos – N (Foliar)
T_5 — Nutraphos super K (Foliar)
T_6 — Sorba spray (Foliar)
T_7 — Nitrophoska liquid (Foliar)
T_8 — NPKMg (Soil) + Urea (Foliar)
T_9 — NPKMg (Soil) + Nutrophos – N (Foliar)
T_{10} — NPKMg (Soil) + Nitrophoska liquid (foliar)

(N. Yogaratnam, D. M. A. P. Dissanayake and B. A. Nandalal)

Efficiency of fertilizer utilization

The effects of different sources of nutrients on growth and yield of rubber is being studied in Experiment F/76/2 and F/76/17 at Pembroke and Eladuwa State Plantations, respectively. The effects of Eppawela rock phosphate and imported rock phosphate on growth and yield being studied at Eladuwa indicates that yield could be increased with application of phosphate, but there had been no differences between the source of phosphate used in this study (Table 5). (N. Yogaratnam and J. G. de Mel)

Table 5. *Effects of phosphate on yield – PB* 86

Treatments	Yield (kg/ha)	% increase
No phosphate	1339	100
Eppawela rock phosphate–level 1	1494	112
„ „ „ –level 2	1496	112
Imported rock phosphate–level 1	1472	110
„ „ „ –level 2	1499	112

Covers and cover management

Residual effects of different leguminous covers grown during the immature phase on production of rubber during mature phase is being studied, at Lowment Estate, Kalutara and Muwankande Estate Mawathagama. The species considered are, *Pueraria* phaseoloids, *Desmodium ovalifolium*, *Centrosema pubescens*, *Stylosanthus gyneusis*, *Calapagonium muconoides*, *Mimosa invisa* and *naturals*. (N. Yogaratnam and J. G. de Mel)

Organic manures

The use of organic manures in immature *Hevea* plantations is being studied at Elston Estate Puwakpitiya (BDN/OM/1) Paiyagala State Plantation (SPN/OM/2) and Hewagama Estate Padukka (SPN/ON/5).

The treatments tested are :

T_1 — NPKMg, ½Normal without organic fertilizer
T_2 — NPKMg, ½Normal with organic fertilizers
T_3 — NPKMg, Normal without organic fertilizer
T_4 — NPKMg, Normal with organic fertilizer

Data obtained at the end of 1986 do not indicate any significant treatment effects. (N. Yogaratnam and F. P. W. Silva)

Soil – Plant – Water relations

Water stress in relation to soil management practices was studied in experiment SM/82/6 at Clyde State Plantation in Kalutara where clean weeded area is compared with natural cover, mixed legumes and dead much cover on growth of immature rubber. Girth measurements recorded at the end of 1986 indicates that girthing in dead mulch area to be much higher than plants under other treatments (Table 6).

Table 6. *Effect of some soil management practices on girth of immature rubber — PB* 86

Treatments	Girth (cm)
Naturals	31.85
Legumes	33.52
Bare (clean weeded)	37.39***
Dead mulch	44.91***
LSD	2.131

In another experiment (SM/83/1) where mulching was used to overcome moisture stress and the effect of this practice on nutrient uptake on N P and K is studied showed (Table 7) that mulching significantly improved girthing. (Lalani Samarappuli, P. Karunadasa and N. Yogaratnam)

Table 7. *Effect of mulching on girthing of immature* Hevea

Treatments	Girth (cm)
No mulch	16.31
Mulch	17.84**
LSD	0.708

Rubber cultivation under irrigation

Two experiments were started at Girandurukotte in the Mahaweli system 'C' area.

Experiment 1 : To study the performance of rubber under irrigation

Experiment 2 : To study the performance of rubber under irrigation inter-cropped with tea in the same area.

In both experiments the soil is well drained deep to moderately deep, dark reddish brown sandy clay loam of the Ulhitiya series type with pH value in the range of 6.0 to 6.5 and CEC 10 me/100g soil. The clones planted include RRIC 100, 102, 103 and 121 which were planted as either bare rooted stumps or poly bagged buddings. Each plot consisted of 45 trees in experiment 1 and 25 trees in experiment 2 and split-plot design was used in each experiment to allocate treatments where the irrigation treatment is in the main plot and clones and method of budding in the sub-plots. Planting of rubber and tea was completed in December. (N. Yogaratnam, D. M. A. P. Dissanayake, A. M. A. Perera, Nandalal, A. K. Yakandawela and B. Gunaratne of the Plant Science Dept.)

Extension

Soil and foliar survey for fertilizer recommendations

All rubber plantations managed by the SLSPC and JEDB are now fertilised on the basis of soil and leaf analysis. The foliar survey programme in 1986 commenced in June and 8542 hectares were covered this year. Computerised fertilizer programme for the next 3 years (1987, 1988 and 1989) were posted to all the estates by December. Urea was the only source of nitrogen recommended. Implementation of this programme would result in a saving of 8.6 million rupees in fertilizer bill to the estate sector of the rubber industry. (N. Yogaratnam, F. P. W. Silva, A. M. A. Perera, Manel Mahanama, Anusha Jayaweera, T. M. Ahamadeen in collaboration with Ruwan Weerasinghe of the Biometrics Section)

Chemical analysis

Routine chemical analysis of soil and leaf samples from survey, experimental and advisory work of the Department were done. Requests from other Research Departments of the Institute, other Research Organisations, Universities, JEDB, CFC, Sri Lanka Standards Institute, Pelwatta Sugar Corporation were also considered. (A. M. A. Perera, Anusha Jayaweera, M. K. Mahanama, Ranjani Munasinghe and T. M. Ahamadeen)

REVIEW OF THE RUBBER CHEMISTRY DEPARTMENT

By

S. W. KARUNARATNE

SUMMARY

The Biochemistry Section was shifted to the Ratmalana complex at the beginning of the year and all the sections of the Rubber Chemistry Department were housed under one roof since March, 1986.

A new type of heat resistant SP rubber based on Tellurium was developed and a research paper was presented at the International Rubber Convention held in Melbourne in April. A new method of graft polymerization using hydroperoxidised latex was tested in the laboratories. Antioxidants based on cashew nut shell liquid and maleimide antioxidants were synthesised. MG rubbers were prepared from both field latex and centrifuged latex. Efficiency of grafting was better with centrifuged latex. Several adhesive formulations based on MG rubbers were prepared and tested. Trials were continued to improve the properties of DPNR. Several trial batches were sent to West Germany for evaluation and further orders are expected as the product is being favoured for specific applications. A campaign to promote DPNR is being launched with the assistance of the EDB. Several modifications of the NR molecule via epoxidation was tried out, such as depolymerisation and grafting of antioxidants by this route. It was possible to graft IPPD to NR and this reaction is studied carefully as it has tremendous potentials.

In the field of rubber technology several achievements are recorded. The use of MBTS/ZDC system has eliminated major scorch problems observed in high hardness vulcanizates. The combined influences of this cure system and petroleum gelly recommended for antiblooming have been found to give very desirable properties. Several projects were completed successfully to develop products to meet stringent specifications required by the export market. Shock protection of army trucks against land mines was one of the major projects undertaken by the section, and several trucks treated with rubber on the inside are being used in field testing. The Rubber Technology Section also assisted in the development of a rubberised coir pad for sea erosion. This work is done in collaboration with coastal protection authorities. Several inquiries from the rubber products sector were entertained and the services rendered by all the sections of the Department helped to overcome their problems speedily and accurately.

The Specifications and Analysis Section continued to fulfil its task in monitoring the TSR production in Sri Lanka. Regular testing of samples, issuing test certificates, inspection visits and analytical services of a general nature were continued by the section throughout the year.

A complete survey of all private crepe and sheet factories were done by the Raw Rubber Development Section in order to assist in the Medium Term Investment Programme to improve the conditions of such factories.

Subsidy visits and regular advisory visits were carried out by the section to JEDB & SPC rubber factories. Experiments on solar drying of crepe rubber were continued.

The Biochemistry Section's main interest was in effluent disposal and treatment. Studies on the uptake of various pollutants from rubber effluents by the water hyacinth plant are underway and based on this work a large scale experiment to test water hyacinth in the biological control of rubber effluents is planned.

DETAILED REVIEW

Staff and staff movements

Mr S. W. Karunaratne, Head, Rubber Chemistry Department also functioned as Acting Director of the Institute from 1 May till 31 December 1986.

Mr S. W. Karunaratne, attended the Expert Advisory Group (EAG) meeting on radiation vulcanization of NR latex from 1 to 3 September in Takasaki, Japan and the ISO/TC 45 meeting on standards for rubber products held in Moscow, USSR from 11 to 18 September.

Dr P. A. J. Yapa, Head, Biochemistry Section served as Acting Head of the Department in Mr Karunaratne's absence.

Dr P. A. J. Yapa, Head, Biochemistry Section attended a meeting of the Malaysian Chemical Congress from 16 to 21 November in Kuala Lumpur, Malaysia.

Dr A. Coomarasamy, Head, Polymer Chemistry Section who was on sabbatical leave in the United Kingdom returned to the Island in February 1986.

Dr L. M. K. Tillekeratne, Head, Specifications & Analysis Section was granted 1 years sabbatical leave from November 1986 to accept a fellowship offered to him by the Royal Society of United Kingdom.

Dr P. A. D. T. Vimalasiri, Assistant Specifications Officer returned from Australia in July after successfully completing his PhD at the University of New South Wales.

Dr L. M. K. Tillekeratne, Head, Specifications & Analysis Section attended a work shop on liquid rubber in Abidjan, Ivory Coast from 20 to 24 January.

Dr M. C. S. Perera, Rubber Chemist attended an International Rubber Conference in Sweden from 2 to 6 June.

Dr (Mrs) K. G. Karnika de Silva, Rubber Chemist attended the International Rubber Conference held in Melbourne, Australia from 29 April – 1 May 1986.

Assistant Rubber Chemists, Mr R. Goonathilake and Miss N. M. V. Kalyani continued their post graduate studies abroad.

Mr E. D. I. H. Perera, Assistant Rubber Chemist left the Island in April to continue his post-graduate studies.

Mr G. Seneviratne and Miss P. Sirimanne, Assistant Rubber Chemists left the Island for post graduate studies at Sussex University in the United Kingdom in October.

Mr L. B. K. Silva, Research Assistant completed a part time course in Electronics Technology at the Institute of Technological Studies, Colombo and returned to full time work from February.

Dr (Mrs) K. G. Karnika de Silva was promoted as Rubber Chemist with effect from 1986.01.01.

Mr T. L. G. Fernando, Assistant Development Officer resigned from his post with effect from 1986.01.09.

Dr W. S. E. Fernando, Head, Raw Rubber Development Section, Mr L. B. K. Silva, Research Assistant and Mrs S. Wickramasinghe, Assistant Biochemist were on duty throughout the year.

Miss N. Kulathilake, Temporary Research Assistant attached to the Biochemistry Section completed her studies on Biological control of pollution in rubber plantations.

Miss K. Jayaweera joined the Biochemistry Section as a Temporary Research Assistant with effect from 1986.04.01.

Mr H. N. K. K. Chandralal, Experimental Officer was granted 1 year's duty leave to follow a MSc Course in Polymer Technology conducted by the University of Moratuwa with effect from 1986.03.17.

Mrs M. Nilaweera, Technical Officer was granted a year's scholarship under the British Technical Co-operation Training Award Scheme and proceeded to the UK for training in end June.

Research Assistant, Mr L. B. K. Silva and Instrument Technicians Miss C. Dissanayake, Miss A. Furlong and Mr. P. Lealwala attended the second work-shop on Repair & Maintenance of Scientific Equipment organised by the British Council from 12 to 22 August.

Mr S. Weerasinghe, Experimental Officer participated in a two weeks course on Minihydropower conducted by Intermediate Technology Development Group, UK and Ceylon Electricity Board.

Miss K. C. S. Dissanayake, Instrument Technician completed the training course in Electronics for Technicians at the Radioisotope Centre, University of Colombo.

Mr D. D. Medagama, Senior Technical Officer was promoted as Experimental Officer with effect from 1986.09.08.

Mr C. N. Wickramasinghe, Specifications Assistant was promoted as Technical Officer with effect from 1986.05.03.

Mr W. D. Dharmasena, Technical Officer who was due to retire on 1986.11.20 was given an extension for a further period.

Mrs I. Denawaka, Technical Officer, Soils & Plant Nutrition Department was transferred to the Rubber Chemistry Department with effect from 1986.10.09.

Mr S. Siriwardena, Technical Officer, was transferred to the Raw Rubber Development Section in October.

Miss K. A. J. Malkanthie, Clerk/Typist resigned from her post in August.

Miss D. M. K. L. K. Daundasekera was appointed as a Technical Officer on 1986.02.03.

Miss H. K. D. C. S. Jayawardene, Miss C. S. Gallage, Miss W. K. C. Nalini and Mr D. P. Wettasinghe were appointed as Technical Officers with effect from 1986.10.01.

Miss A. B. Furlong, was appointed as Instrument Technician with effect from 1986.03.13.

Mr D. Ramawickrama was appiointed as Laboratory Attendant with effect from 1986.11.03.

Messrs M. A. S. P. Meegahapola and H. I. P. Piyasiri were appointed as drivers with effect from 1986.06.02.

Experimental Officers Messrs P. P. Jayasinghe, W. W. D. Y. Jayasinghe, A. S. Dekumpitiya, S. L. Weerasinghe and D. D. Medagama were on duty throughout the year.

Mr Z. E. Irugalbandara, Senior Technical Officer was on duty throughout the year.

Technical Officers, Messrs W. D. Dharmasena, K. M. U. Mithrananda, P. H. Sarath Kumara, M. D. C. Seneviratne, T. A. S. Siriwardena, C. Senanayake, Mrs Nanda Baduge, Mrs S. Weeraman, Mrs C. Kuruppu, Mrs Leela Wanigatunga, Mrs S. Yapa, Miss M. de Costa and Miss M. V. K. Rodrigo were on duty throughout the year.

Mr P. Lealwala and Miss K. C. S. Dissanayake, Instrument Technicians were on duty throughout the year.

Specification Assistants, Messrs W. A. S. Wijesekera, G. Wanigatunga, N. Karunathilake, K. K. Austin, B. Gunasiri, P. D. J. Rodrigo and W. Nandasena were on duty throughout the year.

Mrs A. Paranavitane, Mrs T. Danthanarayana and Mrs I. Wijesinghe, Clerk/ Typists were on duty throughout the year.

Mrs L. Rukmani, Stores Assistant was on duty throughout the year.

Meetings and lectures

The departmental staff conducted several lectures for the benefit of the Estate Superintendents, Factory Officers, Extension Officers of the ASD and staff of the Rubber Control Department. Lectures were conducted both at Sri Jayewardenepura University and Moratuwa University for the MSc students and the NDT (Rubber Technology) students.

The Head of the Rubber Technology Section, Dr W. S. E. Fernando served as the Hony. Secretary of the PRI and he was a member of the Drafting Committee, rubberised coir and packaging materials appointed by the SLSI.

The Head of the Department, Mr S. W. Karunaratne served in the following committees :

Chairman drafting committee of SLSI on NR specifications.

Member of the Chemicals Divisional Committee set up by SLSI.

Member of the Advisory Committee on rubber for the EDB appointed by the Hon Minister of Trade & Shipping.

Director, Co-operative Industries Union.

As the Acting Director, Mr S. W. Karunaratne attended 7 meetings of the Rubber Research Board, 5 meetings of the Board of the NIPM, 7 meetings of the Parliamentary Consultative Committee, 4 staff meetings convened by the Ministry of Plantation Industries, and 1 meeting of the Board of Post Graduate Institute of Agriculture.

The Head of the Department moderated several seminars on current research topics given by members of the staff of the Rubber Chemistry Department.

The Head of the Department organised and conducted a seminar on the subject Rubber Products Manufacture and the role of R & D. The chief guest was the Hon Minister of Plantation Industries and Public Administration and the subjects discussed were : .

(a) The role of R & D in rubber products manufacture.

(b) Problems in the manufacture of rubber based products.

(c) Problems in the manufacture of latex based products.

Training

The vacation trainees (from the Universities) and five in-plant trainees from the NAB were trained during the year. In addition research of five MSc students were supervised by the staff of the Department.

Miscellaneous

Electronic Repair Unit

Mr T. Abeyratne, Electronics Engineer from University of Moratuwa continued to visit the Repair Unit as a consultant.

Repairs to instruments

Repairs were carried out during the year to the following instruments.

Perkin Elmer Gas Chromatograph	Rubber Chemistry Dept.,
Monsanto Rheometer	— do —
Hereaus Oven Model UT 5042E	— do —
Wallace Total solids tester	— do —
Differential Thermal Analyser	— do —
Packard 428 Gas Chromatograph	Plant Science Dept.,

Repairs to the following instruments were started during the year and are still in progress.

Packard 437 Chromatograph	Plant Pathology Dept.,
Hereaus Model VT 5042 EKP Oven	Rubber Chemistry Dept.,
Perkin Elmer UV/Vis Spectrophotometer	— do —
Perkin Elmer Elemental Analyser	— do —

Installation/Commissioning of equipment

The Repair Unit assisted in the installation and commissioning of the following equipment :

(1) Li-Cor Portable Photosynthesis System — Plant Science Dept.,

(2) Memmert Oven — Rubber Chemistry Dept.,

Instron Materials Tester

This instrument was repaired, recalibrated and the instrument is in complete working order now.

Publications

Bradbury, J. H. and Perera, M. C. S. (1986). Dichlorocarbene modified natural rubber, *British Polymer Jl.*, 18, 127.

Bradbury, J. H. Elix, J. A. and Perera, M. C. S. (1986). Comparison of methods of calculations of 13C NMR. Chemical shifts of diene polymers with applications to isomerised natural rubber. *J. Polymer Sci.* (*Polymer Chemistry*) (in press).

Bradbury, J. H., Elix, J. A. and Perera, M. C. S. (1986). NMR Study of hydrobromation reaction and the microstructure of hydrobrominated NR Polymer (Submitted).

De Silva, K. G. K. McWhinnie, W. R., and Stuckey, J. E. (1986). Tellurium Tetrahalides in Rubber Chemistry: Some New Tellurium (IV) Complexes with an S_2X_4 (X=Halogen) Ligand Environment. (*Inoraganica Chimica Acta*, 122 153 - 159.

De Silva, K. G. K., Sirimanne, P. and De Costa, M. (1986). A new type of heat resistant superior processing tellurium rubber. *Proceedings of 7th International Rubber Convention Rubberex* 86, *Melbourne Australia.*

De Silva, K. G. K., Nilaweera, M. and Daundasekera, L. (1986). An improved method for grafting vinyl monomers on the natural rubber (submitted for publication).

Perera, M. C. S., Elix, J. A. and Bradbury, J. H. (1986). A ^{13}C NMR study of hydroxylated natural rubber. *J. Appl. Polymer Sci.* (in press).

Perera, M. C. S., Elix, J. A. and Bradbury, J. H. (1986). Furanised rubber studied by NMR sepectroscopy. *J. Polymer Sci.* (*Polymer Chemistry*) (in press).

Perera, M. C. S. (1986). Surface modification of natural rubber laces. (*J. Appl. Polymer Sci.* (submitted).

Tillekeratne, L. M. K., Perera, M. C. S. and Weeraman, S. (1986). A study of the rate of dissolution of different grades of latex crepe rubber in petroleum solvents. *J. Chem. Technol. Bio Technol.* (submitted)

Vimalasiri, P. A. D. T., Haken, J. K., Burford, R. P., (1986). High-performance liquid chromatographic analysis of polymeric polyisocyanate based polyurethanes after alkali fusion. *J. Chromatogr.*' 351, 366.

Vimalasiri, P. A. D. T., Haken, J. K., Burford, R. P. (1986). Gas chrompatographic analysis of polyether based polyurethane after acid fusion., *J. Chromatogr.*, 355, 141.

Vimalasiri, P. A. D. T., Haken, J. K., Burford, R. P. (1986). Gas chromatographic analysis of polyester based polyurethanes elastomers after acid fusion., *J. Chromatogr.*, 361, 231.

Vimalasiri, P. A. D. T., Haken, J. K., Burford, R. P. (1986). Gas chromatographic analysis of crosslinked polyester based polyurethane foams using tri and tetra-functional alcohols after alkali fusion., *J. Chromatogr.*, 362, 391.

Vimalasiri, P. A. D. T., Haken, J. K., Burford, R. P. (1986). Chromatographic analysis of thermoplastic polyurethanes based on hydroxyterminated polycaprolactones after alkali fusion., *Advance in Chromatography.*, Tokiyo. Elsevier Science, Australia.

Editorial

Karunaratne, S. W. Rubber products manufacture and the significance of Research and Development 1986.

Abstracts

Tillekeratne, L. M. K., Perera, M. C. S. and Rodrigo, H. V. K. (1986). Effect of fresh water and sea water on different grades of crepe rubber.

Coomarasamy, A. and Seneviratne, W. M. G. (1986). Preparation and properties of deproteinised natural rubber obtained by papain treatment.

Coomarasamy, A. and Sirimanne, P. (1986). Prevulcanization studies and preparation of superior processing rubber.

Reports

Fernando, W. S. E., (1986). Premium grades of natural rubber. *Business Lanka Magazine.*

Fernando, W. S. E. (1986). Rubber products manufacture for export. *Ceylon Daily News.*

Karunaratne, S. W., (1985). Annual Review of the Rubber Chemistry Dept.

Patents

De Silva, K. G. K. and Sirimanne. P. Heat resistant superior processing tellurium rubbers.

Yapa, P. A. J. A method for the manufacture of high quality low protein urubber (Sri Lanka Patent No. 9574).

Polymer Chemistry

Antioxidant studies

Studies were conducted on binding of maleimide antioxidants to the unmodified rubber and the amine antioxidant IPPD to the epoxidised natural rubber. The analytical data obtained on the products revealed that these antioxidants have got chemically bound to the rubber chain to a moderate extent. Work is being continued on the techniques and conditions of reactions of achieve a higher binding efficiency. (M. C. S. Perera, A. Coomarasamy, W. M. G. Seneviratne, Sunil Weerasinghe, Chitra Kuruppu and P. P. Jayasinghe)

Superior processing rubbers and prevulcanization studies

A paper on 'Prevulcanization studies and preparation of superior processing rubber' by A. Coomarasamy and Pushpa Sirimanne was presented at the SLAAS Sessions in December 1986. The influence of the stabilizer system for latex and prevulcanization formulations on properties of the product has been studied. For certain adhesive applications such as for wood–wood bonding formaldehyde/sodium hydroxide stabilized latex which has been prevulcanized with a semi EV formulation has been found to be superior to prevulcanized latex obtained from ammonia stabilized latex. However for the manufacture of dipped goods it is advisable to use ammonia stabilized latex either compounded or prevulcanized. For the preparation of superior processing rubber, a freshly stabilized field laetex containing about 0.3 – 0.5% ammonia, is preferred. The studies conducted in our laboratories revealed that the heat resistant type of superior processing grades of rubber could be prepared by choosing a suitable prevulcanization formulation: Several batches of SP 20 and PA 80 type of superior processing rubbers were prepared in our laboratory and at Mawanella Block Rubber Factory. The processing characteristics of these rubbers have been found to be very satisfactory. A 50 kg sample of PA 80 prepared with our assistance at Mawanella Block Rubber Factory was supplied to a rubber product manufacturer for use in a special extruded product. (A. Coomarasamy, S. W. Karunaratne, Pushpa Sirimanne, Mangalika de Costa, Nihal Wickremasinge and Indra Denawaka)

Heat resistant superior processing tellurium rubbers

A paper entitled 'A new type of heat resistant superior processing tellurium rubbers' was presented by Karnika de Silva at the International Rubber Conference, 'Rubberex 86' held in Melbourne, Australia under the sponsorship of Export Development Board and Tellurium Selenium Development Association, U.S.A.

Samples of 10kg tellurium rubber containing different amounts of ethyl tellurac were sent to Weber and Schear, West Germany for further evaluation of their raw rubber properties. It was found that increased amounts of ethyl tellurac tends to decrease the viscosity and PRI of the raw rubber on mastication. Experiments were conducted to partially replace ethyl tellurace with Tetramethyl thiuram disulphide in order to get better improvements in properties and to reduce the cost of the material.

A patent on tellurium rubbers has been filed at the registry of patent and trade marks, Colombo in October 1986. (K. G. Karnika de Silva, Pushpa Sirimanne, Mangalika de Costa and K. M. U. Mithrananda)

Preparation of depolymerized latex and liquid rubber

A method has been developed for depolymerization of natural rubber in the form of latex by the use of nontoxic chemicals as depolymerizing agents. This process has been found to be quite efficient and could be scaled up without much difficulty. However the conversion of depolymerized latex into dry liquid rubber as expected has been found to be the most difficult unit operation in this process. Work is being continued. (A. Coomarasamy, W. M. G. Seneviratne and Nihal Wickremasinghe, Manel Neelaweera and Chitra Kuruppu)

Methyl methacrylate grafted natural rubber

During the period under review, work on this project was carried out on improving the techniques of graft copolymerization as well as on end use applications of MG rubbers.

Samples of MG latex containing 10–49% methyl methacrylate were prepared from field latex and centrifuged latex. The extent of polymerization after 16 hours was found to be about 95% for the samples obtained from the centrifuged latex. However the extent of polymerization was found to be 3% lower than this value for the samples prepared from field latex. Grafting efficiency has not been determined for these samples due to lack of suitable facilities to carry out such analysis. The selective extraction technique was used to remove unbound pMMA and unreacted rubber from the grafted. product. This method gave values in the range of 70–85% for grafted and insoluble components in the MG rubber sample prepared by the use of t. BHP/TEP redox initiator system.

The work carried out also showed that these MG rubbers in latex form and in solution form can be used as bonding agents for wood–wood, leather–leather and rubber leather. MG rubber with 49% MMA content has been found to be the most suitable type for wood–wood bonding. MG latex obtained from centrifuged latex have also been used in RFL systems to treat glass fabric and epoxy subcoated Kevlar fabric to facilitate bonding of these materials to natural rubber compounds during vulcanization. From the results obtained the optimum MMA content in MG latex for this purpose has been found to be 30%. (A. Coomarasamy, Manel Neelaweera, Nihal Wickremasinghe and Kanthi Samarakoon, MSc student)

Use of enzyme treated latex for the preparation of MG rubbers

A Kinetic study was conducted on grafting reactions of papain treated latex with methyl methacrylate monomer. The effect of dilution and maturation of treated latex on grafting has also been studied. Experiments show shorter induction period, high grafting efficiency (by selective extraction technique) and better film forming properties with grafted rubber prepared with treated latex. The main advantage in this method is that it gives a product which can be easily coagulated and filtered. These steps are experienced to be the most difficult steps in the preparation of MG rubbers.

It was interesting to note that the MG rubber could be vulcanized to give very hard products of 90 IRHD with low density, (less than 1) 10 kg samples of each MG 30 and MG 49 rubber were sent to Japan through Associated Traders for product evaulation. The Mawanella Block Rubber Factory has shown interest in large scale manufacture of MG 30 rubber at their factory in future. (K. G. Karnika de Silva, Manel Neelaweera and Lakshmi Daundasekera)

Cotton grafted natural rubber

An attempt was made to graft modified cotton on to NR backbone. Cotton was treated with amides, carboxylated and blended with NR and mixed with peroxides on the mill and vulcanized. An attempt was also made to carry out the research in latex phase. It was noted that there is considerable reinforcement in NR milled with modified cotton but removal of unreacted cotton which appears on the surface of the product is a problem. Further work on this project has to be carried out to find the best proportion of cotton to be added for better end product. (K. G. Karnika de Silva)

NR composites

Arrangements have already been made to obtain all the necessary materials and equipment to carry out the work on construction and testing of NR/high performance fabric laminates particularly for engineering applications. Work has also been initiated on the use of cashew nut shell liquid for the synthesis of suitable bonding resins. A summary of a paper entitled "Bonding of NR to fabrics for the construction of laminated bearings" has been sent to the IRRDB to be included in the programme

for the forthcoming UNIDO workshop on NR composites to be held in Jakarta, Indonesia in February 87. This is based on the work carried out at the MRPRA for the UNIDO Project. (A. Coomarasamy).

Preparation of superior quality rubber by enzyme/chemical treatment

Several trials on the use of papain for the preparation of low protein natural rubber were carried out during the course of this year with the view to gather more information in the effect of various additives and processing conditions on the properties of rubber. Technological and certain engineering properties of these rubbers have been tested in selected practical engineering formulations and these results confirm our earlier findings that resilience, heat build up and compression set are improved by papain treatment. Dynalyser measurements indicated an enhancement of elastic moduli and lowering of loss factor tan values which, in general could be considered as an improvement in the dynamic properties of the material. A paper entitled "Preparation and properties of deproteinised natural rubber obtained by papain treatment" by A. Coomarasamy and W. M. G. Seneviratne was presented at the SLAAS Annual Session in December 86. (A. Coomarasamy, W. M. G. Seneviratne, Nihal Wickremasinghe, Mangalika de Costa, K. M. U. Mithrananda and Manel Neelaweera)

Discussions were held on the subject of setting up a national standard for the low protein natural rubber (LPNR) and officers from all the sections of the Rubber Chemistry Department participated in a preliminary meeting arranged by the Sri Lanka Standards Institution to discuss this subject. There were representatives from the EDB and various producers.

A tonne of low protein natural rubber was manufactured by the improved process, at our RRISL Dartonfield factory and supplied for a commercial order at a premium price. (A. Coomarasamy, P. A. J. Yapa, R. Dahanayake and D. S. K. Ranaweera)

Special latices

Cationic latex

Work on this project was continued with a view to select the most suitable stabilizer systems. Chemical stability, electrical mobility, adsorption properties to materials like wool, cellulose, clay etc. and prevulcanization behaviour were studied. The use of cationic latex for chemical modification reactions such as cyclisation has also been investigated. Preliminary evaluation on the adhesive properties of bitumen rubber emulsion prepared with these latices indicated an improvement in this property. Detailed evaluation is necessary to confirm this observation. (Pushpa Sirimanne, A. Coomarasamy and Mangalika de Costa)

Low nitrogen natural rubber latex

It was found that the latex can be treated with papain in the presence of vulcastab LW or ZnO/TMTD to keep it as a highly stabilized low nitrogen latex. Dilution upto a certain extent is essential before the papain treatment of the centrifuged latex. The stability of latex increases considerably and after about one month the mechanical stability time remains around 1500 sec. Fifteen gallon sample of highly stabilized low nitrogen latex was prepared on a request by Weber and Schear, West Germany and sent through Associated Traders. (K. G. Karnika de Silva and Lakshmi Daundasekera)

Studies on bleaching of rubber

Experiments were conducted on the use of non-toxic chemicals as bleaching agents in crepe rubber manufacture and the results obtained indicate clearly that the new process has potential for commercial utilization. Detailed investigations are being planned. (A. Coomarasamy, Chitra Kuruppu and Nihal Wickremasinghe)

Oil extended natural rubber

Experiments were performed to incorporate different types of oils, Naphthenic and parafinic on to natural rubber field latex. A crumbling agent was added to get the final product in crumb form for easy mixing with carbon black, fillers etc. The technical properties too improved in oil extended natural rubber/carbon black masterbatches when compared with carbon black/oil mixed with natural rubber on the mill. Further work on this project is in progress. (K. G. Karnika de Silva and Lasxhmi Daundasekera)

Rubber Technology & Development

Compounding

MBTS/ZDC system

This system is slowly but steadily gaining acceptance among the more enterprising rubber product manufacturers. The use of MBTS/ZDC system has eliminated major scorch problems observed in high hardness vulcanizates. In addition the combined influence of this cure system and petroleum gelly (for antiblooming applications) have been found to give the desired properties. (W. S. E. Fernando, P. P. Jayasinghe, D. D. Medagama)

Hard rubber vulcanizates

For the first time in the history of the Rubber Chemistry Department the Rubber Technology Section was able to assist an industrialist in total process development of

an item to satisfy an export order. This section undertook to formulate and produce 10,000 pieces of an item having the following specifications.

Hardness	over 95 IRRD
Density	0.98

The trial order was compression moulded in our laboratory in record time (20 days) using a 4 cavity mould. Here again MBTS/ZDC system was used, which provided a safer compound compared to the more conventional MBTS/TMTD system. All compounding work was done in the factory apart from lab scale trials. Around 12,000 pieces were moulded to obtain the required number indicating a reject rate of 16.6%. However a major proportion of rejects were obtained during the initial stages. In the actual production process it was possible to limit the reject rate to around 4.0% (W. S. E. Fernando, P. P. Jayasinge, D. D. Medagama and K. M. U. Mithrananda)

Shock protection

The work on this project was initiated on a suggestion made by the Head of the Rubber Technology and Development Section to the Joint Operations High Command of the Armed Forces in Sri Lanka. The proposal put forward was accepted and after several modifications final proposal was accepted, in principle for further testing. After final blast testing on 27 August the proposal was accepted to be incorporated in the future production models. This was immediately implemented and all manpower in the rubber technology section was diverted from 15 September to fulfil this objective. (W. S. E. Fernando, P. P. Jayasinghe, D. D. Medagama and K. M. U. Mithrandanda)

Resin soling compound

It has also been reported that resin soling materials can be successfully made using MBTS/ZDC system. Vulcanizing temperatures up to 175°C have been used. Even at this temperature the scorch time was long enough to give sufficient mould flow for perfect moulding. It is customery to use sulfenamides in resin soling manufacture (which has a shorter storage safety due to high humidity) together with prevulcanization inhibitor to achiever better fllow. These experiments suggest that MBTS/ZDC system can also be successfully employed in the production of resin soling. (W. S. E. Fernando, P. P. Jayasinghe)

Industrial extension

The following firms requested our services for product development and testing :

(i) (1) Polymer Products Ltd.,
(2) Associated Motorways Ltd.,

(3) Korea Ceylon Footwear Ltd.,
(4) Coirtex Ltd.,
(5) Richard Peries and Company Ltd.,
(6) Hettiarachchi & Company Ltd.,
(7) Chas. P. Haley & Company Ltd.,
(8) C. W. Mackie & Company Ltd.,
(9) Carson Cumberbatch & Company Ltd.,
(10) Maharajah Organisation.
(11) Sri Lanka Rubber Manufacturing Company Ltd.,
(12) Bata Shoe Company.

(W. S. E. Fernando, P. P. Jayasinghe, D. D. Medagama, (K. M. U. Mithrananda and W. C. Dharmasena)

(ii) Of the technical inquiries we received the following two are of interest :

(1) Latex backing of coir carpets – The objective here was to obtain a thin rubber backing for coir carpets. Compounded latex containing a fast accelerator system and carboxymethyl cellulose (CMC) as a thickening agent prevented latex from seeping out on to the top side of the carpet. The use of CMC decrease the drying time appreciably in hot air leaving a dry film of rubber ready for vulcanization. (W. S. E. Fernando and W. D. Dharmasena)

(2) Reprocessed RSS – This sample of reprocessed rubber was received for technical evaluation during the latter part of September. it was decided to compare with RSS material from the same source.

Specification results

These results for RSS material and reprocessed RSS (Rep RSS) are given in Table 1. Apart from the volatile matter content reprocessed RSS was found to be identical to RSS 1 and 2.

Table 1. *Effect of reprocessing on the technical specifications of RSS*

Sample	Dirt	Ash	VM	N_2	Po	PRI
Rep RSS	0.06	0.3	0.6	0.3	34	83
RSS 1	0.06 – 0.03	0.3	1.08 – 1.12	0.3	46 – 57	55 – 87
RSS 2	0.05 – 0.12	0.3	0.94 – 1.55	0.35	46.–.55	85 – 100

Viscoty and mastication studies

The Mooney viscosity of reprocessed RSS rubber is higher than RSS 1 and 2. However Rep RSS showed higher mastication efficiency than RSS 1 and 2.

Table 2. *Effect of reprocessing on the efficiency of mastication*

Mastication Time Mins	Rep. RSS (ML 1+4)@ 100°C	RSS 1 (ML(1+4)@ 100°C	RSS 2 ML(1+4)@ 100°C
0.0	88.0	85.0	76.0
1.0	79.0	79.5	73.0
3.0	64.0	76.5	67.5
5.0	56.5	62.5	61.5
7.0	49.5	59.5	59.5

Since the only difference in the two types is in their VM content it is probable that VM is responsible for the lower mastication efficiency in RSS 1 and 2.

This observation is highly significant and shed light on the analytical data provided by Kobe rubber exchange on Sri Lanka RSS. The high molecular weights observed in masticated Sri Lanka RSS can be related to the high volatile matter content in our rubbers. Further evaluation of Rep RSS is in progress and a detailed report would be provided in the near future. (W. S. E. Fernando, D. D. Medagama and K. M. U. Mithrananda)

Latex Technology

Radiation prevulcanized latex (RPVL)

Several lots of RPVL were tested for film properties.

Rubber sheets prepared from RPVL give excellent surface texture.

RPVL has a very good affinity for fillers and pigments. Bulk fillers such as whiting and china clay mix readily with RPVL.

The following properties should be taken advantage of in the manufacture of a wide range of products from RPVL.

(1) Clarity
(2) Purity
(3) Affinity for fillers
(4) Surface texture of film
(5) Colour blending properties

(S. W. Karunaratne, Pushpa Sirimanne & Mangalika de Costa)

Carbon Black – latex masterbatches

Further trials on the preparation of latex carbon black masterbatches were carried out to find out the method of incorporating the maximum amount of carbon black into latex; 20 phr of HAF Black was used and the DRC of the fresh field latex was determined accurately, before making the masterbatches.

The amount of dispersant in the dispersions of carbon black was reduced to a certain level, because earlier experiments indicated that the higher the amount of dispersant the poorer the adsorption of carbon black to rubber. At the same time there is a significant effect of pH on the incorporation of carbon black, It was found that at pH 11, and at the temperature of 50°C the incorporation is almost 100%. The coagulation, after mixing the carbon black dispersion with latex, was done with 2% HCOOH while the mixture was heated to 50°C. The coagulum with the serum was kept at this temperature for some time and matured overnight for the adsorption of carbon black to be completed. (S. W. Karunaratne, Pushpa Sirimanne, Mangalika de Costa)

Raw Rubber Development

Raw Rubber manufacture

(a) *Recycling of water*

There were inquiries recently regarding the possibility of recycling the water in the manufacture process. An analysis was carried out and the results are given below. Even in the smooth mill (8th pass) still the pH, floating dirt, hardness, of the water was found to be very high and thus use of this water in latex crepe manufacture is not recommended (Table 3).

Table 3. *The impurity level of the water used in progressive milling operations*

Mascerator	Acidity	Floating dirt	Ca mg/ml	Mn mg/ml	Fe mg/ml	Cu mg/ml	Hardness ppm
1st pass	.02N	4.86	.608	.07	.526	.368	high
2nd pass	.019N	2.57	.594	.05	.736	.236	high
3rd pass	.01N	1.33	.463	.02	.789	.144	high
4th pass	.007N	1.29	.405	.04	.526	.171	high
5th pass	.07N	0.51	.565	.03	.763	.013	high
Diamond mill							
1st pass	.003N	0.41	.333	.02	1.65	—	high
2nd pass	.002N	0.25	.362	.01	1.10	—	high
3rd pass	.001N	0.25	.391	—	2.55	—	high
Smooth mill							
1st pass	.005N	.0094	.347	—	0.347	—	0
Control	—	.0032	.579	.01	.121	.368	4

(M. C. S. Perera and C. Senanayake)

(b) *Factors effecting water absorption of crepe laces*

The effect of milling and metallic impurities on the water absorption of crepe laces were studies. It was found that the absorption of water could be reduced by increasing the number of passes.

For example the laces with 6 passes (blanket crepe) absorbed more than 8% water compared to laces which have undergone 12 passes (sole crepe) within 28 days at 100% Relative humidity. This is due to the washing away of hygroscopic substances from rubber during milling. These results suggest that for the lace crepe production increase number of milling than the blanket crepe lace should be recommended. Considering the cost of milling, the number of passes for thin laces should be restricted to 8 (4– mascerator, 3 diamond, 1 smooth). The laces produced with the number of passes absorbed only 4.7% water within 28 days at 100% relative humidity.

The effect of Ca, K and Na on the water absorption of fractionated and unfractioned rubber was studied. It was found that while the nitrogen containing materials control the rate of absorption, the final intake is controlled by the amount of these hygroscopic inorganic residues. (M. C. S. Perera, S. Siriwardene and C. Senanayake).

Effect of water on processing

The effect of absorbed moisture on the processing properties of sheet rubber was studied. The rubber was exposed to 100% humidity in the dessiccator and was allowed to absorb moisture to different levels. The moisture was expected to affect several properties. For example the mill breakdown of the rubber was found to be lower, with increasing moisture contents. As a result the green strength and the tensile strength of the rubber milled for same duration was higher when the moisture is present. The scorch time is also increased by about 2 minutes when 2.3% moisture content is present. The die swell of the extrudate was found to increase with moisture. However the extrudate weight per min is less when water is present compared to a dry sample. (M. C. S. Perera, S. Siriwardena).

Advisory visits to crepe and sheet rubber factories

Seventeen (17) factories were visited during 1986 to advise on various manufacturing difficulties. Several factories were advised on the resiting of miles.

The water of Yatawatta State Plantation was analysed for calcium and it was found that the water in the area contains a higher calcium content which is the cause for precoagulation. Permission was sought from Matale Regional Board to install a cheap and commercial water purification system to find out whether such a system is economical.

Mirishena State Plantation has a drying loft with rediator on the ground floor. A study was undertaken to find out whether this could be converted to an effective drying tower. It was found that the radiator surface area is sufficient to dry about 5500 kg of rubber and also by few modifications to the loft, a drying tower of about 4000 kg in two lofts could be achieved. After a detailed study a report was submitted on the boiler and radiator requirements of the Divituari and Elpitiya drying towers.

The sole crepe laces of Atale estate was found to be too thick which resulted in a rough surface in their sole crepe. Further this delayed drying causing dullness. This was reported in the study made on the Atale Estate factory.

There was a request from the SPC general office to look into discolouration of crepe produced in some factories. Several factories were visited to find the cause for the discolouration. It was found that all the estates visited supply nearly 70% of the rubber in forward contracts and no complaints were received for the rubbers. It is the substandard rubber that on standing undergoes discolouration. After detail investigation it was found that all the factories handled some part of their crop which is coagulated outside and the coagulum is kept for nearly 72 hrs without milling. Further these coagula are prepared by inexperienced staff who has no knowledge about coagulation of latex (fractionation, bleaching agent addition) for crepe manufacture. This gives a substandard rubber which is more susceptible to discoloureation.

Twenty seven (27) factories were visited on the factory subsidy programme.

Seven (7) factories were visited for latex weighings. (M. C. S. Perera, S. Weerasinghe and C. Senanayake)

Surveys

Medium Term Investment Programme

To extend the MTIP loan for the development of private crepe rubber factories a survey was carried out covering all the private factories. Since the scheme is only to rehabilitate the existing factories by providing new equipment etc., the scrap rubber factories were eliminated as none of them were interested in new machinery. Our recommendations and the approximate expenditure involved is given in table 4.

Table 4. *Cost of inputs for the modernisation of twenty private crepe factories* (*Rs* x 1000)

Year	1988	1989	1990	1991
Building premises	5088	3183	233	193
Plant & machinery	7546	6216	3083	3780
Vehicles	2917	4328	2020	1390
Water supply and power	1170	1375	635	185
Other	355	191	95	—
	17076	15293	6066	5548

(M. C. S. Perera, S. W. Karunaratne, S. Weerasinghe, C. Senanayake)

Crepe rubber market survey

A market survey was initiated to find out the various factors for effective marketing of crepe rubber Originally this will be conducted locally and already letters have been sent inquiring whether they use latex crepe rubber. This will be done in collaboration with the Export Development Board. (M. C. S. Perera)

Drying

Air dried sheets

Several modifications to the internal duct system was done to improve the drying conditions. A temperature of 60°C could be achieved inside the chamber (without rubber) compared to the 47.2°C achieved before the modifications. To maintain the temperature at 60°C for 9 hour, 81.8 kgs of firewood was consumed. When 200 kg of sheet rubber is loaded only a maximum temperature of 50°C was achieved and as a result the rubber was dried only after 6 days. 3 yards of firewood was consumed during these 6 days. This indicates that further improvement of the drying system is necessary and the modifications are now complete. In the cardamon drier (examined in Dukanda, Matale) the heat from the furnace is released through the duct without a back pressure. The present modifications were done keeping this in mind. As soon as the repair in the furnace is over trials could be continued.

Solar drying of crepe rubber

The work on this project was continued throughout the year. Measurement of temperature at several points were recorded by varying the fan speed. The results are given in Table 5.

Table 5. *Effect of blower speed on the temperature of the air passing through the system*

Blower speed (rpm)	Maximum tem.°C			
	Inlet air	Duct inlet	Duct outlet	Difference
850	36.5	65	46	9.5
1050	34	66	51.5	17.5
1250	35	70	60	25
1550	36	70	62	26
1630	35.8	70	59	23.2
185	35.2	68	57	21.8
1980	33	66	53	20.0
2050	35.2	66	55	19.8

This indicates that the blower speed of 1550 rpm gives the maximum temperature rise. Since during the day (when the solar energy is maximum) the drying tower is kept open for loading and unloading purposes there was no effect inside the tower. Further when the hot air through the duct is bulked inside the tower there was no effect. Therefore it was decided to convert the ducting to the smaller tower. (M. C. S. Perera and P. Lelwala)

Shrinkage of crepe laces while drying

The study was undertaken to find out the percentage of shrinkage of crepe leced during drying. It was found that the laces increase in length nearly 4.5% inside the tower and shrinks nearly 6% when taken out. These findings should be taken into account when designing drums for rolling the smooth laces. (M. C. S. Perera and C. Senanayake)

Drying towers

A design and an estimate was submitted to the Galle Regional Board in collaboration with the Premier Engineers to trap the heat losses through the tea dryer and use it in the crepe drying tower at the Deviturai State Plantation.

Trials were commenced at Pallegama Estate to evaluate the possibility of improving drying by forcing air through the tower. (M. C. S. Perera & S. Weerasinghe)

Vacuum drier

The evaluation of the vaccum drier installed at Frocester Group was commenced in the early part of the year but had to be stopped due to factory resiting and further modification to the drier. The trials were recommenced in October and the results of the trials giving a comparative evaluation of drying cost is given in Tabel 6.

Table 6. *A comparative assessment of the drying cost using the conventional drier and the vaccum drier*

	Vaccum drier		Conventional tower
Trial No.	1	2	
Load (in kg. of dry rubber)	738.4	992.5	—
Total time (hrs)	31½	43½	—
Max. temp. (°C)	36.5	40	—
No. of KWH units	135.9	181.1	—
Power cost per kg dry rubber	26.6	27.0	—
Firewood/kg	—	—	13.0
Labour/kg	5.9	5.9	5.9
	32.5	32.3	22.0

Some of the drawbacks are

(1) Long drying time.
(2) Non uniform drying.
(3) Higher cost.
(4) Difficulty in controlling the temperature.

All these drawbacks we feel is due to some defects in the drier and this has now been conveyed to the authorities for necessary action before any further trials.

It is also found that the PRI of vacuum dried rubber is lower than the conventional dried rubber. (M. C. S. Perera and C. Senanayake).

Depolymerization

A system involving hydrogen peroxide is developed to depolymerise natural rubber by exposing to UV light. A molecular weigth as low as 13,000 could be achieved using this method. (M. C. S. Perera and C. Nalini)

Increase in Mooney viscosity of rubber

It was found that with increase in maturation of latex with ammonia, the Mooney viscosity for the resultant rubber could be increased. The results of the trial are given in Table 7.

Table 7. *Effect of maturation of latex (ammonia preserved) on the viscosity of the raw rubber*

Maturation period (hrs) Control	Mooney viscosity
24	80.5
48	83.5
72	97.0

(M. C. S. Perera and C. Senanayake)

Raw rubber antioxidant

A raw rubber antioxidant supplied by Weber and Schear was evaluated. An increase of 32 units in PRI could be achieved by adding 5% of the dispersion but with and adverse effect on colour((M. C. S. Perera and C. Senanayake)

Chemical reactions

(a) *Epoxidised natural rubber :*

Reaction of ENR with amine type antioxidant was tried. IPPD was mixed with ENR latex and the reaction was carried out at different temperatures at different pH values. PRI and Nitrogen content of extracted rubber gave an estimate of bonding. The best conditions for bonding was found to be in basic media. (M. C. S. Perera and C. Nalini)

(b) *Peroxide Vulcanization*

$FeCl_3$/HNS system with hydrogen peroxide has been developed to prevulcanize latex and rubber with a swell index of less than 2% could be obtained. (M. C. S. Perera and C. Jayawardene)

Specifications & Analysis

TSR production

During the year under review the following block rubber samples were tested.

Code	Producer	No. of Samples
AA	Sri Lanka Rubber Manufacturing Company Limited, Natural Rubber Complex, Mawanella.	491
AB	Cenat Block Rubber Factory, Paiyagala.	495
AC	Ceymac Rubber Company Limited, Colombo and Horana.	5879
AD	Statcon Block Rubber Factory, Getahetta.	1821
AF	Sherman Sons, Ingiriya.	2325
AI	Associated Traders, Colombo 13.	31

The Head of the Specification & Analysis Section inspected all TSR factories on a regular basis.

Effect of sea and fresh water on crepe rubber

Results of this experiment have shown that the sea water contamination of crepe affect technological properties to a great extent than the fresh water contamination. Further absorption of water by yellow fraction rubber is much greater, than the absorption of water by fraction removed white crepe rubber. In samples containing higher ash contents, the water absorption was seen to be much higher. Hence it was concluded from these results that both the proteins and lipids in the rubber as well as inorganic salts naturally present in the rubber cause the rubber hygroscopic. A paper was presented to SLAAS sessions 1986 on this work. (L. M. K. Tillekeratne, M. C. S. Perera & Wasantha Rodrigo)

Rate of dissolution of crepe rubber in solvents

Results of this experiment indicated that the fraction removed white crepe rubber dissolves fast in petroleum solvents without leaving a residue. But the yellow fraction rubber containing mostly non rubber constituents will go into solution at a faster rate as gel particles. But not as a thin rubber solution. Results of this experiment too were also presented to SLAAS sessions 1986. (L. M. K. Tillekeratne, M. C. S. Perera and Shriyanthi Weeraman)

Liquid rubber

Attempts were made to manufacture liquid rubber using microwave irradiation. Natural rubber samples were subjected to microwave irradiation in a National NE–7670 microwave oven for a period of 5 to 60 minutes at 100°C. It was observed that considerable molecular cleavage could be achieved using microwave. It was also found that peptizers such as tolyl mercaptan (Nexobleach), pentachlorothiophenol (Renacit 7) and 2,2, – Dibenzxmididodiphenyl–disulphide (Pepton – 44) catalyse the cleavage reaction, hence lower molecular weights could be achieved by incorporation of such peptizers. Molecular weight studies are being carried out to estimate the most active peptizer and its optimum concentration for the commercial manufacture of liquid rubber((L. M. K. Tillekeratne and P. A. D. T. Vimalasiri)

Quality problems of natural rubber

Processing behaviour of RSS rubber produced in Sri Lanka was compared with that of Thailand and Malaysia in order to find out whether there is a considerable difference in processing behaviour as Japanese claim. It was found that all the RSS samples tested had initial Mooney viscosities less than that of Thai and Malaysian rubbers. This will disprove the claim that Sri Lanka RSS is harder (*i.e.* initial Mooney viscosity is higher) than that of Thailand and Malaysia.

Volatile matter (VM) content of almost all the Sri Lanka RSS samples were higher than that of Thai and Malaysian rubber. But our RSS is either superior or there is no significant difference as far as its behaviour during Banbury mixing is concerned. We could not find any correlation between the VM content and the discharge temperature of rubber after Banbury mixing. VM had no significant effect on viscosity reduction of NR during Banbury mixing.

Reduction of Mooney viscosity during mastication of Sri Lanka rubber was from 75 to 54 (*i.e.* 21 units) while the drop for Malaysian and Thai, RSS were from 94 to 62 (*i.e.* 32 units.) This would disprove the claim that Sri Lanka rubber degrade faster at latter stage of mixing although its initial viscosity is higher.

VM content and thickness were studied for 200 samples of RSS collected from number of leading shippers. It was observed that average VM content of RSS sheets having average thickness above 3 mm. is 1.29 whereas that of RSS sheets having thickness below 3 mm. is .89. This will give clear indication that VM content of Sri Lanka rubber is higher because of the large number of sheets having thickness higher than their standard thickness. We will be able to reduce the problem of higher VM content by providing facilities to the RSS manufacturers to produce RSS having thickness below 3mm((L. M. K. Tillekeratne, P. A. D. T. Vimalasiri).

Biochemistry

The Biochemistry Section which was based at the Head Quarters in Dartonfield was shifted to more spacious premises at Ratmalana from 1 March 1986.

A good part of the time was spent on the shifting operation and also to get acclimatised to the new environment.

Effluent disposal

Studies were continued and very high priority was given to this work.

Skim serum samples were analysed for COD, BOD and total solids. Arrangements have been made to analyse the same for mineral ions too.

The trial with the two model systems were commenced during the year.

Arrangements were made to initiate the proposed field trial at Frocester State Plantation.

Visits were made to Maha Oya Estate and Sorana State Plantation in connection with effluent disposal problems.

Effluent samples were also tested for coliform bacteria at Water Resources Board labs.

Studies on the uptake of various pollutants from rubber effluents by water hyacinth plant were also attempted. (P. A. J. Yapa, Nishadi Kulathilaka, K. P. Jayaweera, W. W. D. Y. Jayasinghe, Sriyani Yapa and M. D. C. Seneviratne).

Studies on brown bast

Investigations were continued. Attempts made to purify the amino acid extracts had to be abandoned due to poor recovery from the ion exchange columns and this will be repeated with a new ion exchange resin.

Work on Phospholipase–D activity in F–serum was restarted, towards the end of the quarter. Tests are in progress with the samples collected at the beginning of the quarter. Results are satisfactory and further work is in progress. (P. A. J. Yapa, Seetha Wickremasinghe, Sriyani Yapa, W. W. D. Y. Jayasinghe and M. D. C. Seneviratne)

REVIEW OF THE BIOMETRY SECTION

By

W. N. WICKREMASINGHE

SUMMARY

Two new Technical Officers were added to the staff.

A significant growth was seen in the volume of analyses provided to research departments of the Institute. This could mainly be attributed to the vast array of data sets received for analysis from temporary post-graduate and under-graduate students carrying out projects at the Institute. There were about 250 analyses from Soils and Plant Nutrition Department alone and the total number of sets received from these students was well above 350.

The analyses of data of the rubber smallholder survey carried out by the two Assistant Agricultural Economists in collaboration with the section, was completed and a summary of results was prepared.

Expertise gained during the previous year in using the BBC-Micro and the package INSTAT, enabled the section to double it's quantum of analyses under taken during the year, which also enabled more explorative and extensive work to be carried out. Ever increasing demand for almost all types of statistical analyses, saw the need for a more advanced package such as SAS and a suitable computer to run it.

DETAILED REVIEW

Staff

There was an addition of two new Technical Officers to the section. One of them, Mr L. P. P. Vitharana who was appointed on 1986.01.01 was mainly engaged in meteorological work while the other, Mr T. Dissanayake, appointed on 1986.03.03, was assisting the programmer.

The Biometrician, Mr W. N. Wickremasinghe, the Programmer/Systems Analyst, Mr A. R. Weerasinghe, the Senior Technical Officer, Mr L. T. Peries and the Technical Officers, Mr R. A. P. Abeypala and Miss J. D. Nandani were on duty throughout the year.

Publications

Samarajeewa, P. K., Liyanage, A. de S. and Wickremasinghe, W. N. (1985) Relationship between the incidence and Severity of *Colletotrichum Gloeosporiodes* Leaf disease in *Hevea. Jl. Rubb. Res. Inst. Sri Lanka*, 63 (in press)

Reports

Wickremasinghe, W. N. (1986), Annual Review of Biometry Section

Lectures

A series of lectures on "Computer Usage" was organised by the section and given by R. Weerasinghe, Programmer/Systems Analyst, as an additional service to the scientific staff of the Institute.

Workshops

A. R. Weerasinghe attended a one-day workshop, in Colombo on "Computer Application in Agriculture", organized by the Computer information Technology Council (CINTEC).

Routine Statistical Service

This consists of two types of services

One is the assistance provided to the research officers of the Institute in their routine projects as well as special projects leading to post-graduate degrees. The other is the assistance given to temporary students, carrying out research for under-graduate and post-graduate degrees, attached to various research departments of the Institute. During the year under review, there was a significant increase in the latter type mainly due to increased demand for analysis of large volumes of data. As far as short term projects of under-graduates were concerned, there were frequent requests for various analyses on huge vo'umes of data within short periods of time. However, these requests were met by the section's staff wherever possible. and at few occasions extra expenses were incurred on over time work to fulfil this task.

The statistical services rendered are summarized below under each department.

Plant Science Department

Experimental data from various projects were analysed and interpreted, for the Annual Review of 1985. A few other routine projects were also assisted in the form of analysis and interpretation.

Apart from these, statistical assistance was provided to an officer in his work on Gas Exchange Studies of *Hevea* Clones, leading to a PhD degree.

Genetics & Plant Breeding Department

In addition to the analysis of experimental data for the 1985 Annual Review, a few data sets were received for analysis during the course of the year. One of these corresponds to Genotype and Environment experiment where there are 10 clones in a completely randomized design with 10 replicates, repeated in 7 different sites. Girth data for the first 9 years (immature and mature) from this experiment were received for analysis during the final quarter. Due to the nature of the design and the complexity of analysis when missing plots were present, the assistance of a powerful computer package such as 'SAS, had to be sought and the help was received from the Department of Statistics and Computer Science of the University of Colombo and also from an officer of the CINTEC who had volunteered to help us with SAS facilities. However, problems were encountered with computer internal memory limitations and therefore the analyses were not completed before the end of the year.

Plant Pathology Department

Data for the Annual Review 1985 were analysed and interpreted.

During the first two quarters, assistance was provided in the analysis of part of the data on a project entitled "*Phytophthora* on rubber, pathogen taxonomy, survival and disease control" leading to a PhD by one of the research officers. Analyses included simple means, standard errors and Analysis of variance along with mean comparisons. The accumulated data, of another research officer working on a project entitled. "Studies on Biological Nitrogen Fixation of Leguminous Cover Crops in Rubber Plantations of Sri Lanka" leading to a PhD, were analysed and interpreted.

The date were derived from,

(1) Estimation of Biological Nitrogen Fixation
(2) Response to inoculation in cover crops
(3) Effect of combined N on growth and nodule function of common cover crops
(4) Time cause of acetelene reduction
(5) Diurnal variation in acetelene reduction activity

The analyses included Analysis of variance, mean comparisons, standard errors of means and response equations.

One of the major analyses handled by the section was that of the PhD project, of a research student under a NARESA grant entitled "some comparative Biological Aspects of Nutrient cycling in Rubber Plantations, a Pinus Plantation and a Rain Forest". Data from 8 different experiments of this project were analysed and interpreted this year. One of these data sets (*i.e.* Litter fall) was computerized due to the large volume of data available and the iterative type of analyses requested on them. In another occasion,

linear and exponential functions were fitted to soil nutrient data to see the relationship between the nutrient level and depth. Exponential decay function was found to be a better fit.

Assistance was also provided to a research student working on the project "Disease Investigation of Intercrops of Rubber" leading to an M. Phil Degree. As a part of this study, growth characteristics of 100 *Phytophthora* isolates each with 3 replicates, were analysed and interpreted. Growth measurements of Cocoa were also analysed. Non-linear type curves were fitted to this infection growth data over a period of 5 days, for a selected sample of 5 varieties.

Soils and Plant Nutrition Department

Routine work for the 1985 Annual Review was completed in the month of January.

Continuous help was provided throughout the year, to a research student working on the project "Potassium and Magnesium nutrition of *Hevea* and associated covers" leading to an M Phil degree. Under this project, there were 10 field and 2 pot experiments. Designs were fully randomized, randomized blocks and split plot, with factorial structure of K & Mg.

The following is a summary of the volume of data analysed from this project during the year.

Expt. No.	Variables Analysed	No. of data sets
1–3	Girth, Leaf N, P, K, Ca, Mg	8
4–6	Girth, Leaf N, P, K, Ca, Mg	8
7	Girth, Leaf N, P, K, Ca, Mg	8
8	Girth, Yield, Leaf N, P, K, Ca, Mg	7
8	Latex N, P, K, Ca, Mg & PH	6
8	Soil N, P, K, Ca, Mg & PH	6
9	Girth, Yield, Leaf N, P, K, Ca, Mg	7
9	Latex N, P, K, Ca, Mg & PH	6
9	Soil N, P, K, Ca, Mg & PH	6
10	Girth, Leaf N, P, K, Ca, Mg, Mn	16
10	Soil N, P, K, Ca, MG, Mn, PH	14
10	Disease plants	01
11–12	Girth, Leaf N, P, K, Ca, Mg, Mn	16
11–12	Soil N, P, K, Ca, Mg, Mn, PH	7
11–12	Ratios : K/Mg, K/Ca & K/ (Ca + Mg)	6
	Total	122

Data from 2 experiments of the project titled "Effects of fertilizers on growth and mineral composition of *Hevea* seedlings grown in the field nursery" were analysed and interpreted. The design of the experiments was a $3 \times 3 \times 3 \times 3$ factorial, confounded in blocks of 9 units. Variables analysed were Girth (3 assessments per each), Height (3 assessment per each), Leaf N, P, K, Ca & Mg (2 assessments per each) and soil N, P, K, Ca & Mg (one assessment). Altogether there were 42 sets of data. Analysis was based on Analysis of Variance (ANOVA) techniques and the final results from the ANOVAS were used for fitting response equations to each variable.

In addition to the above mentioned work, experimental data of 3 temporary students working on their BSc final year projects, were analysed and interpreted (One student working on the project "The effect of Aluminium on the uptake of Phosphorus by *Pueraria phaseoloides*" had 24 sets of data corresponding to various parameters, for analysis, while another one on the project "Studies on some aspects of sulphur nutrition on *Hevea* plantation", had 37 data sets. The third one on "Effect of herbicides on soil characteristics and weed control under *Hevea*" carried another 12 sets bringing the total number of data sets from these students to 73. The final year project of another temporary student was also assisted in the ways of guidance in the analysis and interpretation of results.

There was a total of about 250 data sets from this department during the year, for analysis.

Biochemistry Section

Further assistance was provided to the research student working for a MSc degree on the project "Role of Aquatic Plants in Effluent Treatment System in Rubber Plantations", in the analysis and interpretation of data. The data of another temporary student working on a related project were also analysed and interpreted.

Independent Research

The data of the rubber smallholder survey carried out by the Assistant Agricultural Economists in collaboration with the Biometry Section were analysed and a preliminary report was prepared towards the end of the year. The analysis of this survey data collected during the final quarter of 1985 and the 1st quarter of 1986, took a considerable length of time due to lack of free time for independent work owing to the pressure of routine work and also due to the nature of the sampling design which was a 3–stage one with unequal sub–classes. The preliminary report of results was sent to the former Director of RRI, who originated the idea of the survey, for his comments and advices on the final material to be published.

Computer Work

Expertise gained during the previous year in using the BBC–micro and the statistical package INSTAT, enabled the section to double it's quantum of analysis undertaken during the year, while also enabling more explorative and extensive interactive work to be carried out.

Facilities

During the year, the new commercial statistical package INSTAT, in it's "chip version", was loaned to the RRI by Colombo University. This new version while enhancing the capabilities of the package, also produced more consistent and reliable results, thus building user confidence leading to increased efficiency in data handling and analysing.

Correspondingly however, there was a loss of confidence in the DG/CS/5 micro which was planned to be used for meteorological data storage, resulting in an undecided role for this computer in the future. Towards the latter part of the year, a new awareness of the availability of an advanced statistical package (SAS), prompted the section to pursue the possibility of acquiring a computer capable of running this at the RRI. This package has been evaluated as a 'must' for all research organizations by many including the consultants from Reading University. We hope that this facility will be available to the Institute during the early part of 1987.

Work Undertaken

The largest single job of computer work undertaken and carried out during the year was the storage, management and analysis of the "smallholder survey" data collected by the Assistant Agricultural Economists.

Another survey, to compare yields of RRIC 100 series clones with those of PB 86, also carried out by the above, for the Genetics & Plant Breeding Department, was also computerized, and was in progress at the end of the year.

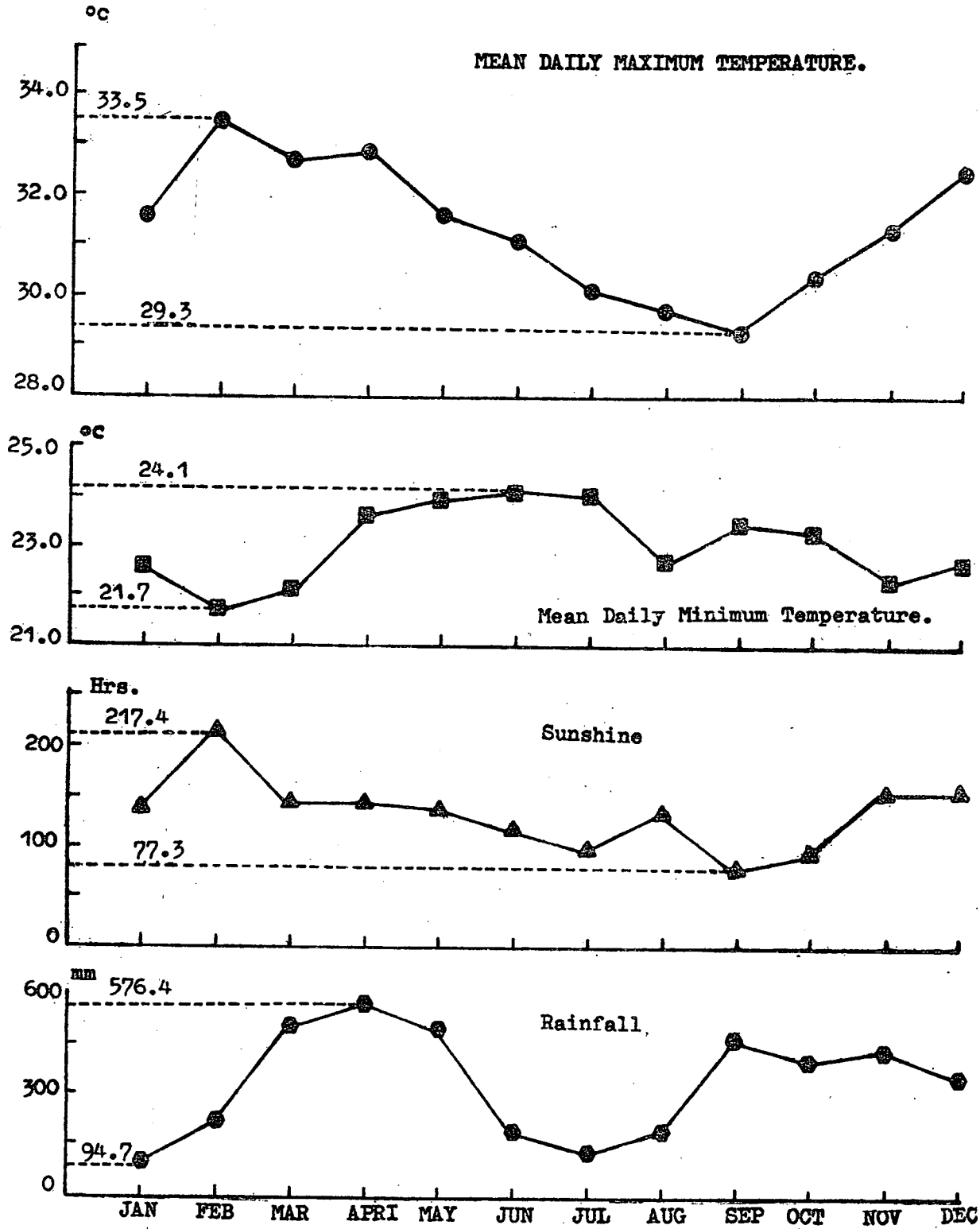
During the year, a simple program was also developed to handle certain calibration calculations of the Soils & Plant Nutrition Depeartment.

Finally a commercial spread sheet was being used to produce output required by the Ministry from a "smallholder factory survey" undertaken by the Rubber Chemistry Department. This is due to be completed in the early part of 1987.

Meteorology

The appointment of a new Technical Officer to handle meteorological work of the section, helped bring a backlog of weather records upto-date. A stock of rainfall recorder charts and temperature/humidity charts were also received this year. Two officers from the Department of Meteorology visited our station on our request and inspected the instruments for necessary repairs and calibration and remedial action was taken on their recommendations.

A visit was made to the Nakiadeniya Oil Palm Plantation in connection with the instruments installed at the site. Routine meteorological work at the Dartonfield station was continued uninterrupted. Due to limitations and lack of facilities available with DG-CS/5 computer, the work on the development of software for weather data recording and retrieval on this computer, was suspended. The graph of rainfall temperature and sunshine duration at Dartonfield is shown in Fig. 1.


°c
MEAN DAILY MAXIMUM TEMPERATURE.
34.0
33.5
32.0
30.0
29.3
28.0
°c
25.0
24.1
23.0
21.7
21.0
Mean Daily Minimum Temperature.
Hrs.
217.4
200
Sunshine
100
77.3
0
mm
600
576.4
Rainfall
300
94.7
0
JAN
FEB
MAR
APRI
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC

REVIEW OF THE LIBRARY AND PUBLICATION SECTION

By

VIJITHA JAYARATNE

SUMMARY

The routine work of the Library and the Publications Section *i.e.* maintaining, processing and publishing of the Institute's regular publications and collecting and disseminating of information on all aspects of natural rubber (NR) has been carried out successfully throughout the year 1986.

DETAILED REVIEW

Staff

Mrs Vijitha S. Jayaratne, Librarian and Publications Officer, Mr D. C. Thambawita, Library Assistant and Assistant Publications Officer and Mrs R. Amaratunga, Clerk/ Typist, were on duty throughout the year. Miss L. T. Ramanadan, Library Assistant and Assistant Publications Officer attached to the Colombo Office Library, resigned from the post on 30 December 1984.

Acquisitions

Though the number of text books ordered for the year 1986 were curtailed, the procurement of essential periodicals was maintained. As our Library consists of most of the essential periodicals which are important to our Research Officers as well as to those from other Research Institutes and Universities. the back copies of periodicals were bound to maintain the series and to enable the information searches to have easy access for reference work.

Inter Library Loans

The above scheme was useful to us as well as to other libraries in obtaining urgent reprints of valuable articles which they cannot obtain from their own libraries. Fifty four copies of articles were sent to various libraries on request and received 12 copies on requests made by our officers.

Publications

Printing and circulation of our publications were done regularly. Three volumes of the Proceedings of the 1984 International Rubber Conference consisting of 70 papers were published. Last volume is with the printers. The five year plan of the future work of the Research Departments were printed for the use of the Research Officers.

The following publications were printed during the year :

Publication	Volume
Annual Review	1985
Annual Report	1985
Journal	63
Conference Proceedings	1 (1 & 2)
Conference Proceedings	2 (1)

Information Services

Dissemination of information

Routine work on disseminating of information *i.e.* circulating contents pages of current scientific journals among the Institute's Scientific Staff, indexing of articles from Abstract Journals etc., were done regularly.

Agricultural Information Network (AGRINET)

The work of AGRINET was maintained throughout the year 1986 too. Contents pages requested by the AGRINET Users were sent out without any delay and contents pages of Journals requested by our Staff were circulated when received from NARESA.

REVIEW OF THE ESTATE DEPARTMENT

By

L. R. DAHANAYAKE

SUMMARY

The estate known as Dartonfield Group, belonging to the Research Institute, comprises of Dartonfield & Gallewatte Divisions in Agalawatta and Nivitigalakele Division in Matugama. The extent of the Estate is 332.04 ha and planted area is 278.70 ha of which 195.89 ha were in bearing during the year.

The South-West and North-East monsoons merged resulting in an unusual weather pattern. Weather conditions that prevailed during the cropping months were unfavourable for harvesting of crop. However the total crop harvested this season is the highest since 1981.

16.80 ha were replanted with clone RRIC 100/RRIC 121 and the uprooting of old rubber trees in the area to be replanted in 1987 commenced. This is in keeping with the accelerated replanting programme for the period 1986 to 1989. The subsidy payments for rubber replanting was also approved by the Rubber Controller at the rate applicable to private sector holding.

No symptoms of *Oidium* leaf disease were noticeable, but late winters suffered some leaf fall. The incidence of *Phytophthora* leaf disease was negligible; trees affected with *Regidoporus lignosus* were treated with 'Collar Protectant' fungicide, and the multiplication plant of clone RRIC 103 affected with *Corynespora* were treated with 'Dithane M.45'.

Budwood of clones of RRIC 100, 121 and PB 86 continued to be in demand and issues to all estates & smallholders were made accordingly. Budwood of clone RRIC 103 was withdrawn, following the outbreak of *Corynespora* leaf disease and all plants in the multiplication nursery were cut back and subsequently uprooted.

All agricultural operations were carried out in mature and immature areas and nurseries of the Group.

The profit made during this season is Rs. 6/32 per kilo; which was the highest since 1974.

Staff

Mr H. E. S. Don Peter the Estate Superintendent resigned from the Institute on 15 March to join the Sri Lanka State Plantations Corporation. The Assistant Estate Superintendent of Kuruwita Substation, Mr S. A. R. Samarasekera was transferred temporarily to Dartonfield to overlook the estate till a new Superintendent was appointed. The writer assumed duties as Estate Superintendent of Dartonfield Group on 6 August.

Miss T. H. C. Silva was appointed as Junior Assistant Clerk with effect from March.

The Assistant Factory Officer Mr D. S. K. Ranaweera was promoted as Factory Officer with effect from 1 March.

Mr W. D. D. Senanayake the Field Supervisor of Gallewatta Division was transferred to the factory as Factory Supervisor with effect from 15 March.

Mr A. K. Piyasena, daily paid Office Labourer was appointed as Office Peon with effect from 15 March.

Mr A. A. Ariyaratne, Cheif Clerk, Mr K. K. P. Gunawardena, Acting Senior Assistant Clerk, Mr K. D. Sumanasena, Junior Assistant Clerk, Messrs N. L. D. Piyadasa, A. K. D. Hemapala, S. K. S. de Silva and H. M. J. Premalal, Field Officers, Messrs S. R. Vadivel and T. Somaratne Field Supervisors, Mrs C. S. Hettiarachchi Creche Attendant and Mr H. W. Amaradasa, Tractor Driver were on duty throughout the year.

The Dartonfield Group cadre stood at 18 at the close of the year made up as follows :

Senior Staff	01
Assistant Staff	14
Minor Staff	03
Total	18

Agricultural Advisor

Mr E. A. Hermon, Factory Consultant, Tea Small Holdings Development Authority visited the property thrice as Agricultural Advisor during the year and preliminary work scheduled reports on these visits were submitted to the Rubber Research Board.

Hectarage

A summary of the hectarage is given in Table 1.

Table 1. *Land distribution in Dartonfield Group (in hectares)*

	Dartonfield	Gallewatta	Nivitigalakele	Total
Mature area	20.50	131.47	43.92	195.89
Immature	21.81	43.31	—	65.12
Nurseries	7.28	1.80	8.61	17.69
	49.59	176.58	52.53	278.70
Paddy fields	—	1.25	—	1.25
Abandoned area	—	—	8.06	8.06
Swamps	—	—	1.21	1.21
Uncultivated rocky area & earthslip area	3.25	1.40	2.62	7.27
Jungle	—	—	.71	.71
Streams reservation	.03	—	—	.03
Roads	3.27	1.29	.32	4.88
Buildings	16.14	6.00	7.79	29.93
Grand total	72.28	186.52	73.24	332.04

Weather

Rainfall figures for 1986 and 1985 are given in Table 2.

Table 2. *Rainfall distribution for* 1986 & 1985 *in Dartonfield Group (mm)*

	1986	1985
January	157.9	314.4
February	183.0	158.1
March	492.4	300.2
April	615.6	214.8
May	481.0	681.4
June	182.7	717.4
July	129.7	208.8
August	225.0	464.5
September	478.1	362.3
October	402.7	438.5
November	426.8	489.9
December	544.6	851.7
	4319.5	5202.0
Total wet days	229	231

The highest rainfall was recorded during the month of April and was 615.6 mm on 21 days. September proved to be a wet month with 27 wet days resulting in very poor intake of crop.

Crop

The yield data for the last 5 years are given in Table 3.

Table 3. *Yield records from* 1982 — 1986 (*Kg/ha*)

	1986	1985	1984	1983	1982
Dartonfield	1015	825	865	838	772
Gallewatta	1114	741	924	804	875
Nivitigalakele	648	635	781	667	864
Total	1049	730	884	779	858
Estimated	870	913	889	1052	1124
Tapping (ha)	196	213	197	205	209

The 1049 kg yield per hectare recorded this year is the highest since 1982.

The crop harvested this year exceeds last season by 49700 kg. and represents 113% of the season's estimated crop exceeding the estimate by 23956 kg. The crop harvested this season is the highest since 1981.

113 days tapping was not possible due to unfavourable weather conditions and recovery tapping was done on 36 days.

Tapping cuts were marked with appropriate guide lines for bark consumption according to the systems of tapping adopted.

The tapping panels were treated with fungicides.

Manufacture

A summary of manufacture records during the year is given in Table 4.

Table 4. *Details of manufactured crop in Dartonfield*
(Aggregate of latex & scrap percentages)

Latex grade	Total crop (kg)	(%)
Pale Crepe No. 1	205435	89
Pale Crepe No. 2	200	—
Pale Crepe No. 3	10710	04
Scrap Crepe No. 1	10644	05
Scrap Crepe No. 2	3587	02
Scrap Crepe No. 3	1050	—
Total crop manufactured (inclusive of 26205 kg. of bought latex;	23x626	100

31400 kg of thin crepe was supplied as forward contract during the year. 1000 kg of De-proteinized natural rubber was manufactured for M/s. Associated Trades.

The estate continued buying latex from the smallholders of the neighbourhood and the total bought latex manufactured at the end of the year was 26205 kg.

The smallholders were paid a price almost on par with net sales average.

Factory machinery

All machinery in the rubber factory were in need of repairs, accordingly, estimates were called for and repairs to the following three mills were attended to, during the season under review.

Mill No. 1	—	Grooved	—	26" x 14"
Mill No. 7	—	Smooth	—	26" x 14"
Mill No. 8	—	Smooth	—	26" x 14"

Replacing of 200 G.I. sheets of the factory roof and repairs to the stair case and the loft and drying tower have been done.

Agricultural operations

Routine weeding, manuring and all other agricultural operations were carried out. The immature areas were in satisfactory condition and were maintained up to the required standards of agricultural practice. Growth was satisfactory and the cover crops were well maintained.

Roads

The road leading through the earthslip area was metaled and tarred.

All motorable roads within the Group were maintained with cleaning out of drains as well, throughout the year.

Pests and diseases

The incidence of *Corynespora* leaf disease, was detected around September which developed into a severe attack, not only in the nurseries but in immature and mautre fields as well. Defoliation was widespread and control measures, such as thermal fogging was carried out by the Plant Pathology Department, The fungicides used, were Dithane M. 45/ Benlate & Captan 50% W_p, for fields and nurseries respectively.

The clone affected was RRIC 103, and accordingly all polybag nurseries and budwood nurseries were treated as well.

Incidence of this attack is still evident and control measures are being continued.

Replanting

1986 *Replanting* 16.80 *ha — clone RRIC* 100/*RRIC* 121 *— Gallewatta Division.*

The planting of this area was done with poly bagged plants and bare root plants during the South-West monsoon and was completed.

1987 *Replanting* — 12.69 *ha Dartonfield*

Uprooting commenced together with preliminary work.

Nurseries

All nurseries were well maintained.

Field and factory experiments

The Research Departments were given the necessary assistance in carrying out their field and technological experiments.

Institute buildings.

The G.I. roofing sheets of the staff bungalows, offices and other buildings were completely painted with 'Sylvan Green' and the premises were maintained by cleaning the gardens and repairing the barbed wire fences as well.

Labour and health

24 Labourers have been retired on their having reached the retiring age, and 387 new labourers have been recruited as casual workers during the year under review, to cope with the field work associated with the enhanced replanting programme, and intensification of tapping in these areas.

Wages were paid during the year in accordance with the Wages Board Ordinance in force. Festival advances were paid as required. Incentive Bonus and the Annual Holiday Pay Wages were paid to the labourers in accordance with the ordinance.

Line room accommodation was satisfactory. Repairs to line rooms and lavatory were attended to, where necessary.

All non-working resident children over 1 year of age and below thirteen years continued to be issued with ½ lb. of bread per day per head.

In addition, fortnightly cash payment were made in lieu of half cream milk to resident non-lactating mothers with infants under 1 year of age.

The health of the entire estate population was satisfactory during the year. The Dysentary epidemic that broke out in September on Gallewatta Division was brought under control with the assistance of the Public Health Inspector of Agalawatta and his team. Those who contracted this epidemic totalled 19, and only 01 death was recorded.

National tree planting campaign

03 'Na' plants were planted in 03 Divisions of the Estate on the 17 of September to commomorate the 80th birth anniversary of His Excellency the President J. R. Jayawardene, followed during the week by planting of fruit trees (77) in staff bungalows and Jack plants (4900) and Alostonia timber plants (2550) in the earthslip areas and also in the replants, along the boundary.

Accounts

The final accounts for the year 1986 is in progress.

Estimates

Estimates of Capital and Revenue Expenditure for 1987 in respect of Dartonfield Group were submitted to the Rubber Research Board and were approved.